CALIFORNIA FISH AND GAME

"CONSERVATION OF WILDLIFE THROUGH EDUCATION"

VOLUME 44 JULY, 1958 NUMBER 3

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CALIFORNIA FISH AND GAME

VOLUME 44 JULY, 1958 NUMBER 3

Published Quarterly by the
CALIFORNIA DEPARTMENT OF FISH AND GAME
SACRAMENTO

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CHANGE OF EDITORSHIP

With this issue, Carol M. Ferrel of the Game Management Branch assumes the duties of Editor-in-Chief of *California Fish and Game*.

Mr. Ferrel's assumption of the editorship follows the department's policy of rotating the editorship of its quarterly technical journal between staff members representing Game Management, Inland Fisheries, and Marine Fisheries.

For four years Mr. Ferrel, whose position is Game Management Supervisor, has served as Editor for Game with the publication. Through this service he has gained a knowledge of the policies and procedures of the journal.

Under his guidance, the journal will continue its policy of presenting to the interested public the results of scientific investigations in a readable manner and relating them to management programs and the conservation of California's wildlife resources.

Mr. Ferrel will be ably assisted in his duties by three associate editors. John Fitch will continue as Editor for Marine Fisheries. He will be joined by Elton D. Bailey, representing Inland Fisheries, and Merton N. Rosen, representing Game Management.

To Mr. Shapovalov, Editor-in-Chief the past four years, we wish to express our appreciation for a job well done.—*Seth Gordon, California Department of Fish and Game.*

EFFECTS OF VEGETATION REMOVAL ON SPRING FLOW[1]

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INTRODUCTION

California ranchers and sportsmen are converting large acreages of brush to grassland to increase forage for livestock and game. In many cases this change in plant cover has resulted in an increase in spring and stream flow. Our objective was to make quantitative measurements of this increase and to observe the situations under which the increase occurred.

This study was made chiefly in the foothills of Madera County at elevations ranging between 1,200 and 3,000 feet; one small segment of the study was made near Clear Lake in Lake County. Climate is typically Mediterranean, with precipitation falling principally in the winter and spring; the summers are long, hot, and dry. In the Madera County foothills precipitation varies with elevation from about 15 to 30 inches annually. Most of the soils are granitic with high infiltration capacity.

The vegetation is woodland-grass (Figure 1). Trees and shrubs are most dense on north exposures and at the higher elevations where moisture is more plentiful. The principal trees are digger pine (*Pinus sabiniana*), blue oak (*Quercus douglasii*), interior live oak (*Q. wislizenii*), and buckeye (*Aesculus californica*). The buckeye leaves dry in July prior to the time when moisture stress is greatest. Blue oak is deciduous but the other species are evergreen. At the higher elevations, California laurel (*Umbellularia californica*) and foothill ash (*Fraxinus dipetala*) are found occasionally.

Principal shrubs are chaparral whitethorn (*Ceanothus leucodermis*), buckbrush (*C. cuneatus*), Mariposa manzanita (*Arctostaphylos mariposa*), bush lupine (*Lupinus albifrons*), redberry (*Rhamnus crocea*), poison oak (*Rhus diversiloba*), and squaw bush (*R. trilobata*). The shrubs are evergreen, except for the two species of *Rhus*. These begin to dry in late July or early August.

The herbaceous plants are mainly annuals and are dry about the first of May at 1,200 feet elevation and two or three weeks later at 3,000 feet. Summer weeds, particularly tarweed (*Hemizonia virgata*), are abundant in some years.

Along stream courses the trees are chiefly white alder (*Alnus rohmbifolia*), willow (*Salix* spp.), sycamore (*Platanus occidentalis*); shrubs

[1] Submitted for publication, November, 1957. This study was done under Federal Aid in Wildlife Restoration Project California W-51-R, "Big Game Investigations."

FIGURE 1. Typical woodland-grass vegetation on north exposure at 1,500 feet elevation in Madera County, California.

are mule fat (*Baccharis viminea*), and button willow (*Cephalanthus occidentalis*). All of these are deciduous except mule fat.

Woody vegetation has increased on the study area in recent years and ranchers have control-burned, or bulldozed and chemically treated from 10,000 to 20,000 acres of brush each year converting to grassland. After the first control-burn in July, 1949, water was observed to have increased in a creek adjacent to the burn. Thereafter, the general procedure in the study was to measure spring flow before and after plant cover manipulation. This was done by clocking the time required to fill a quart bottle, or by measuring the actual amount of water collected in 15 minutes or an hour. In some cases the springs were measured only once or twice per day but in others every hour throughout the day. An attempt was made to use water meters but those used were not sensitive to small flows.

A few studies have been reported showing the effects of brush removal on spring flow. Numerous ones, however, have shown that the removal or reduction in brush or trees have increased the water available for streamflow; others have shown an actual increase in water yield (1, 5, 7, 11, 14, 17). A study in San Benito County showed a spring to increase in flow after the brush and trees were cut around the spring in a radius of about 100 feet (13). Some of the larger oaks were chemically treated with 2,4,5-T. Leonard and Harvey (10) reported that brush was successfully sprayed with chemicals to increase irrigation water.

SPRING FLOW DATA

This section will present the case histories of the springs measured in Madera and Lake Counties over the past nine years. Three of the springs served as checks to indicate trend in flow throughout the sum-

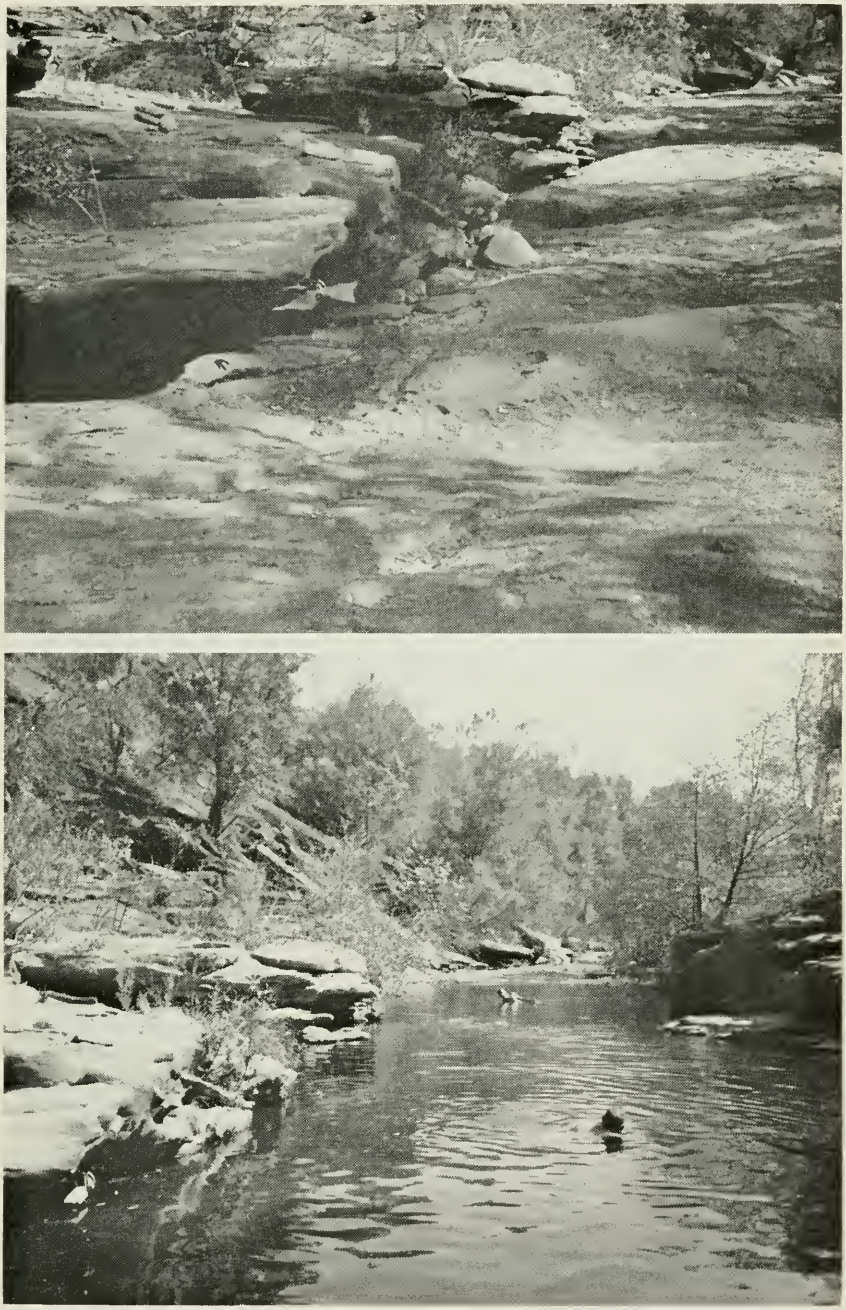

FIGURE 2. (Upper) Taken in Finegold Creek on August 17, 1949, before control-burn on August 20th. (Lower) Rephotographed on September 14, 1949. The hole had filled with water and flow in the rapid was the size of a man's wrist. Weather was clear and hot during the interval.

mer without manipulation of plant cover. The springs were named after some feature in the vicinity.

Finegold Creek

Finegold Creek lies between two control-burns made in the summer of 1949, the first on July 17th, the second on August 20th. The burns bordered the creek on each side for approximately one mile. The fires burned and killed about 10 percent of the riparian vegetation which consisted chiefly of white alder and mule fat.

On the banks and above, the shrubs and trees consisted chiefly of chaparral whitethorn, buckbrush, Mariposa manzanita, redberry, poison oak, squaw bush, bush lupine, digger pine, interior live oak, blue oak, and buckeye. These species were about 65 percent top-killed on the upper slopes but less so near the stream course where the fires were set.

One seep was found in the edge of the stream bed next to the second burn; this was nearly dry before the fire.

Following the first burn, water increased in certain places in the creek but no photographs were taken or definite measurements made before the burn. Three days prior to the second burn, photographic stations were established in the stream bed which was nearly dry except for depressions that had filled with water following the first burn. These stations were re-photographed on September 14th, about three weeks after the burn when water was flowing down the creek (Figure 2). One could not be sure how much of the increase in flow was due to killing of the vegetation in the stream bed and on the slopes, or to the gradual decline in transpiration that occurs in the early autumn before the leaves normally fall (15). Also, the days were getting shorter. Cooler weather was not a factor since this period was uniformly clear, hot, and dry.

Grapevine Spring

The watershed above this spring was 59 acres. It was control-burned on August 20, 1949. Coverage of brush and trees before the fire was estimated as 50 percent. The reduction in transpiration area of these by burning was approximately 80 percent.

The spring produced 76 drops of water per minute before the fire, equal to 1½ gallons per day; 24 hours after the fire it produced one quart per minute, equal to 360 gallons per day. Measurements were made nine days and 24 days after the fire; the flow continued at about one quart per minute. In addition, a seep developed about 50 yards above the spring.

Measurements of this spring were continued during the summer of 1950. The flow on August 24th was about equal to that on the same date after the fire in 1949. On August 24th a large grapevine near the spring was cut (Figure 3). After this the flow increased by about 15 gallons per day. Before cutting, the difference in morning and afternoon flow amounted to eight seconds per quart. After cutting it amounted to only three seconds, which indicated that most of the increase came from reduced transpiration (Figure 4).

Five days after the grapevine was cut, on August 29th, six interior live oak, two blue oak, one digger pine, and two whitethorn chaparral

FIGURE 3. Grapevine Spring. The large grapevine and trees were removed from area of spring to study effect on water flow. Arrow points to location of spring.

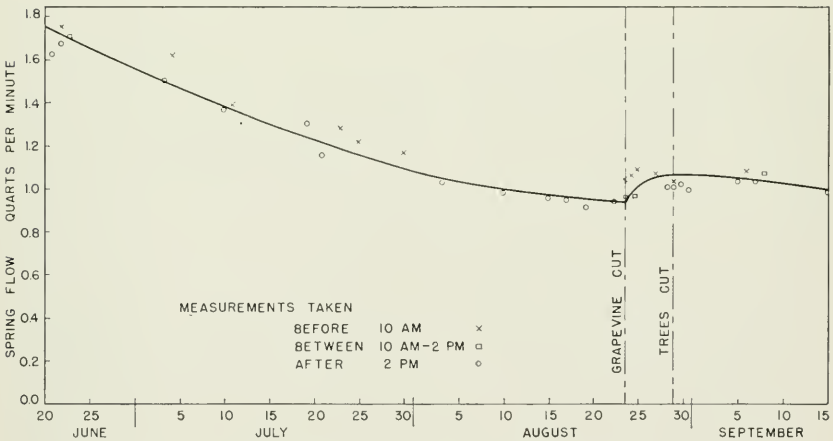

FIGURE 4. Flow of Grapevine Spring before and after removal of grapevine on August 24th, and trees on August 29, 1950.

plants near the spring were cut. This did not give any increase in spring flow.

In the early summer of 1951 the seep above the spring was developed for livestock water, which prevented further measurements.

Tank Spring

The watershed above this spring was long and narrow and covered about 25 acres. It was control-burned on August 9, 1950. The kill of brush and trees was excellent. The crown cover of shrubs and trees was estimated to be 90 percent. The species composition and top kill were as follows: buckbrush 15 percent, kill 95 percent; whitethorn chaparral 10 percent, kill 95 percent; interior live oak 55 percent, kill 99 percent; California laurel 5 percent, kill 99 percent; buckeye 8 percent, kill 80 percent; foothill ash 5 percent, kill 99 percent; chamise (*Adenostoma fasciculatum*) 2 percent, kill 75 percent. The kill was nearly 100 percent for a considerable distance around the spring.

Tank Spring was shallow and seepage water came from the walls of the drainage above the spring or pipe outlet for a distance of 35 feet. Seepage increased after the fire. Spring flow following burning was more than double that before burning, increasing from about 198 gallons per day to 486 gallons (Figure 5).

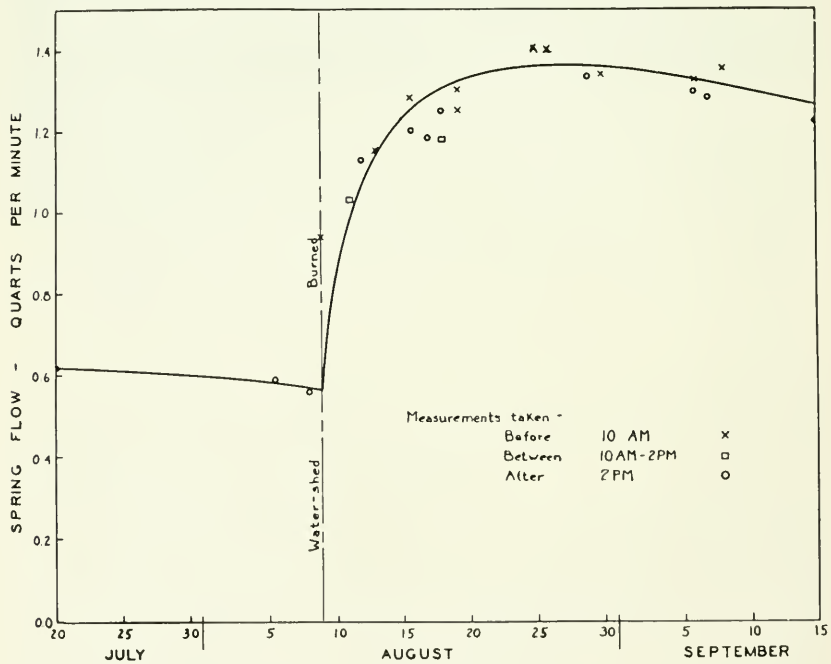

FIGURE 5. Flow of Tank Spring before and after control-burn on August 9, 1950.

Pipe Spring

The watershed above Pipe Spring was 10 acres in size. The area was control-burned on August 5, 1950. Crown cover of shrubs and trees was 10 percent. The species and percentage top-kill were as follows: blue oak 25 percent, kill 60 percent; interior live oak 15 percent, kill 75 percent; poison oak (dry) 50 percent, kill 90 percent; buckbrush 5

percent, kill 50 percent; digger pine 5 percent, kill 50 percent. In addition, two small grapevines, two small interior live oaks, and two buckbrush plants all near the spring were cut by hand.

Flow of the spring increased after burning and cutting for three or four days but then the trend continued downward at a rate equal to that before treatment (Figure 6). The net result was that the flow was set ahead about 15 days.

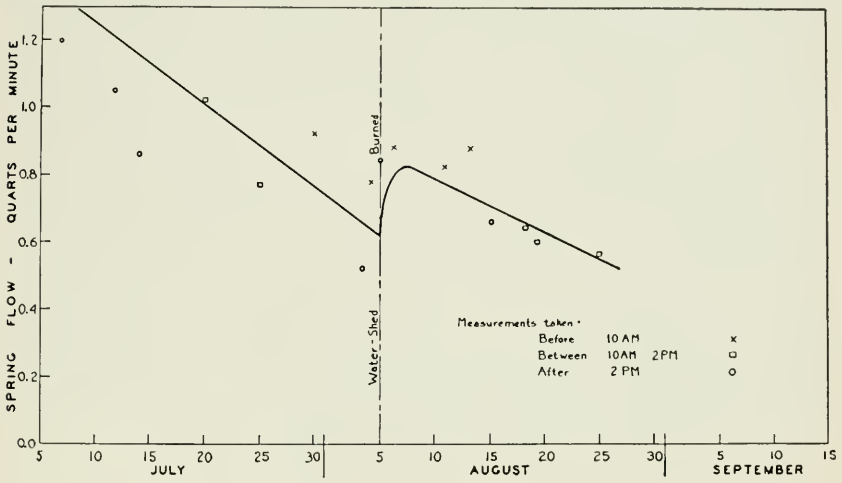

FIGURE 6. Flow of Pipe Spring before and after control-burn on August 5, 1950.

Rock Spring

This watershed was one of five acres. It was control-burned on July 22, 1950. The crown cover of shrubs and trees was estimated to be 65 percent. The species composition and degree of top-kill were as follows: whitethorn chaparral 50 percent, kill 85 percent; buckbrush 15 percent, kill 85 percent; digger pine 10 percent, kill 85 percent; interior live oak 15 percent, kill 90 percent; manzanita 3 percent, kill 95 percent; blue oak 2 percent, kill 75 percent; buckeye 3 percent, kill 90 percent; redberry 2 percent, kill 90 percent.

The spring water comes from a crack down about 10 feet in solid rock. Several years ago the spring furnished water year-long for a homesteader. However, the ranch owner reported that in recent years it had gone dry each summer.

Before the control burn the spring decreased rapidly in flow and, although the control burn produced an excellent top-kill, no change in trend of flow was found. Apparently the deep-rooted trees and shrubs had already depleted the water at this time (Figure 7).

This spring was measured several times in 1951 between September 12 and October 24, at the time of the first fall rain; also on August 8, 1952, August 30, 1955, and August 13, 1957. The flow data per day are shown in Table 1.

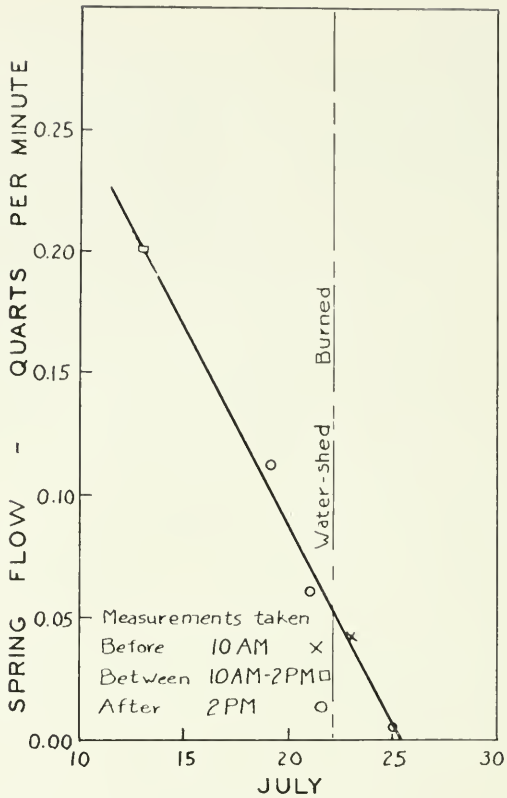

FIGURE 7. Flow of Rock Spring before and after control-burn, July 22, 1950.

TABLE 1
Flow Data for Rock Spring

Date	*Gallons*
September 12, 1951	474
September 28, 1951	511
October 8, 1951	406
October 24, 1951	408
August 8, 1952	840
August 30, 1955	628
August 13, 1957	732

If all measurements had been made on the same date each year the variation, no doubt, would have been smaller. Precipitation for the years of study was recorded as follows for the San Joaquin Experimental Range, about one mile away: 1949-50, 16 inches; 1950-51, 21.4 inches; 1951-52, 24.7 inches; 1952-53, 15.7 inches; 1953-54, 15.6 inches; 1954-55, 16.7 inches; 1955-56, 26.5 inches; 1956-57, 14.5 inches.

The watershed was reburned on July 26, 1952. Its appearance on June 21, 1950, before burning and in August, 1957, is shown in Figure 8.

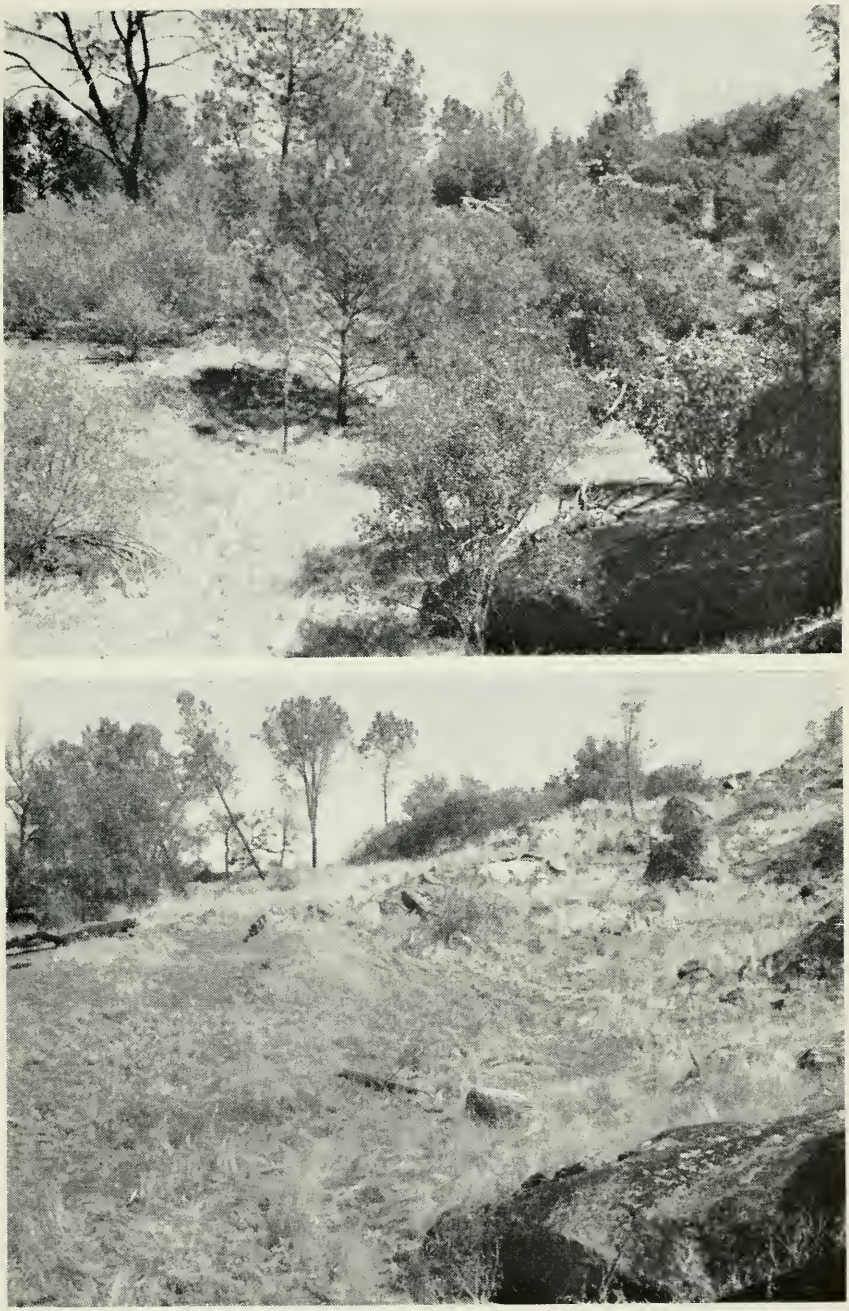

FIGURE 8. A portion of Rock Spring watershed on June 21, 1950, before burning, and (lower) in August, 1957, after two re-burns.

Mine Spring

Within 30 feet of this spring were eight button willows, three interior live oak clumps, three coffeeberry bushes, three medium-sized digger pines, and one blue oak. All of these were cut by hand on July 11, 1950. The watershed above was not burned.

Before the cutting was done the spring had been decreasing in flow rapidly as shown in Figure 9. Thereafter, the spring increased in flow for about 15 days and then decreased and stopped flowing again about six weeks after it went dry the first time.

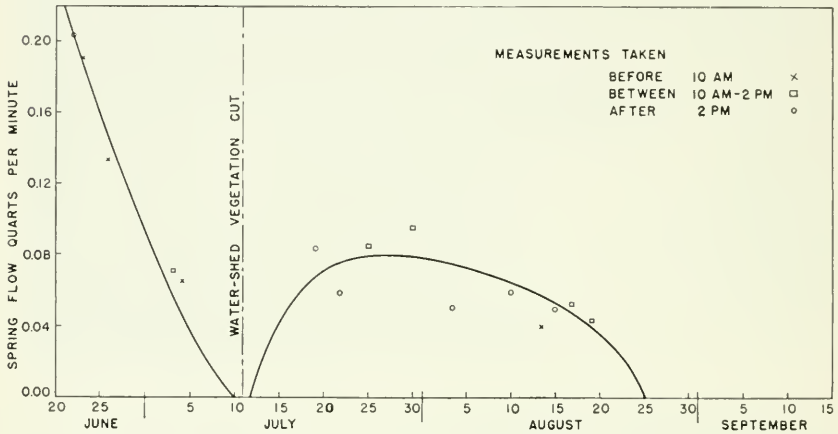

FIGURE 9. Flow of Mine Spring before and after cutting shrubs and trees within a radius of 30 feet, 1950.

Spring House Spring

This served as a check spring with no manipulation of cover. It was located about one-quarter mile from Mine Spring. It was deep-seated, the flow coming from beneath a large rock. Measurements were taken

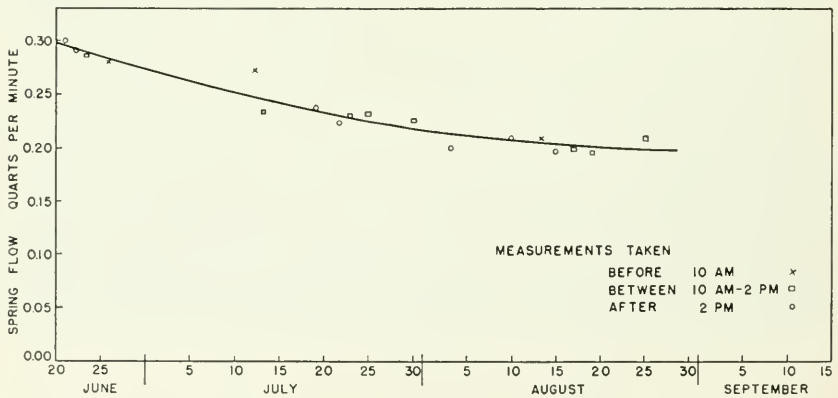

FIGURE 10. Flow of Spring House Spring where there was no manipulation of cover. This served as a check, 1950.

beginning June 20th and ending September 1st (Figure 10). There was a gradual decrease in rate of flow throughout this period. However, it was a little more rapid early in the season than later. This may have been due to drying of poison oak and buckeye on the slope above and less use of water by these plants after about mid-July.

Cap Hill Spring

This was also a check spring. Its watershed had few shrubs and trees. The rate of flow was gradually downward from July 15th to September 5th (Figure 11). The rancher reported that the spring flowed better than it did the summer before when he had to remove the cattle from the range pasture because of a lack of stock water. Rainfall in the winter and spring season of the year before was about four inches less than the year of measurements. This probably accounts for the difference in flow.

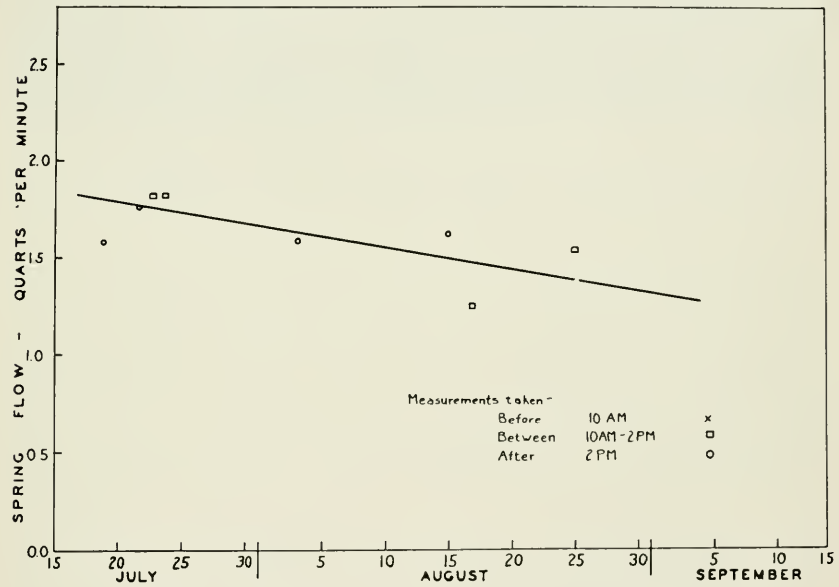

FIGURE 11. Flow of Cap Hill Spring. This served as a check, 1950.

Willow Spring

This spring was found within a few miles of Clear Lake in Lake County. It was surrounded by a clump of willows as shown in Figure 12. The willows formed a closed canopy about 35 feet in diameter and were 12 feet tall in the center. The spring was boxed, with sidings 38 by 51 inches. No other woody vegetation was near the spring, but up the hill about 150 yards were a few blue oaks and 50 yards higher were blue oaks, manzanita bushes, interior live oaks, and poison oak. The watershed was estimated at 7 to 10 acres.

FIGURE 12. Clump of willows at Willow Spring as it appeared before cutting August 9, 1950. Thirty minutes before cutting the rate of flow was sharply downward; 30 minutes after cutting began the rate of flow was sharply upward.

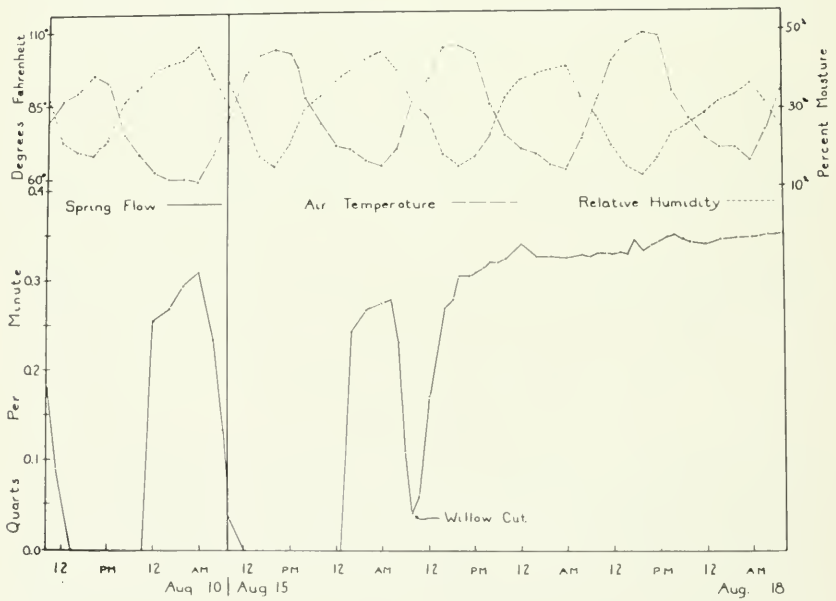

FIGURE 13. Measurements of spring flow, air temperature, and relative humidity at Willow Spring before and after cutting willows in 1950.

Beginning at 10 a.m. on August 9, 1950, records of spring flow were obtained every two hours until 10 a.m. the next day. Temperature and humidity records were obtained also. The spring flow and weather records are shown in Figure 13. Spring flow for the 24 hours amounted to 44.9 gallons. At 1 p.m. water in the spring box fell below the outlet and was down one and one-eighth inch at 6 p.m. It then rose to three-quarters of an inch by 8 p.m. and water came from the outlet at 10.30 p.m.

Spring flow records were again obtained every two hours on August 15th. For this day the flow amounted to 31¼ gallons. The day was hotter and drier than August 9th. Flow from the spring stopped at 12 noon and began again 30 minutes past midnight. At 6 p.m. water in the spring box had been one and three-quarters inch below the pipe outlet.

After the flow was measured for 24 hours, cutting of the willows began at 10 a.m. on August 16th. One person removed the willows in two hours. Cutting the willows had about the same effect on the spring flow as opening the faucet on a garden hose. The flow began to increase almost immediately and continued to increase rapidly until the cutting was finished. Thereafter the spring flow continued rather uniformly day and night. The flow was measured every hour during daylight and every two hours during night for 48 hours after cutting. On the second day the spring produced 122.0 gallons of water, in comparison with 31.5 gallons before the willows were removed. Therefore, the clump of willows had been using at least 90.5 gallons of water per day. Other measurements taken on September 5th, 11th, and 12th, showed the spring to increase by about another 20 percent as the area around the spring became recharged. When this increase is figured against the decrease that would normally occur with downward trend in flow, the water use would amount to about 124 gallons per day.

The willows sprouted shortly after cutting and further measurements were made periodically in 1951, 1952, and 1953, as indicated in Figure 14. Generally the trend in spring flow was downward except for fluctuations which corresponded with temperatures and water use by the willows. Sprout growth in 1951, 1952, and 1953 is shown in Figure 15.

Each year, measurements of spring flow were made hourly for two 24-hour periods: August 8-9 and 15-16, 1951; August 11-12 and 18-19, 1952; and August 12-13 and 19-20, 1953. The results for one of the

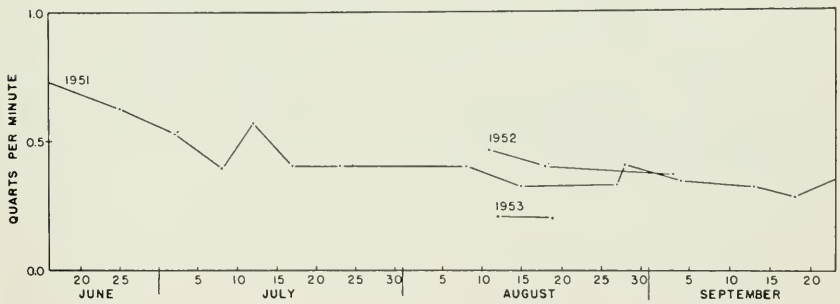

FIGURE 14. Trend in flow of Willow Spring in 1951, 1952, and 1953.

FIGURE 15. Re-growth of willow sprouts after cutting in 1950: in 1951 (upper), 1952 (middle), and 1953 (lower). Sprouts were re-cut in 1953 after lower photograph was taken.

periods in each year are shown in Figure 16. These were within three days of the same date, but the temperatures and humidity varied considerably, the temperature being lowest in 1952. If we use the maximum rate of flow which occurred at approximately 6 a.m. as the potential and then subtract the actual amount of water produced we obtain a partial answer to the amount of water used by the willows. The data for the three years are shown in Table 2.

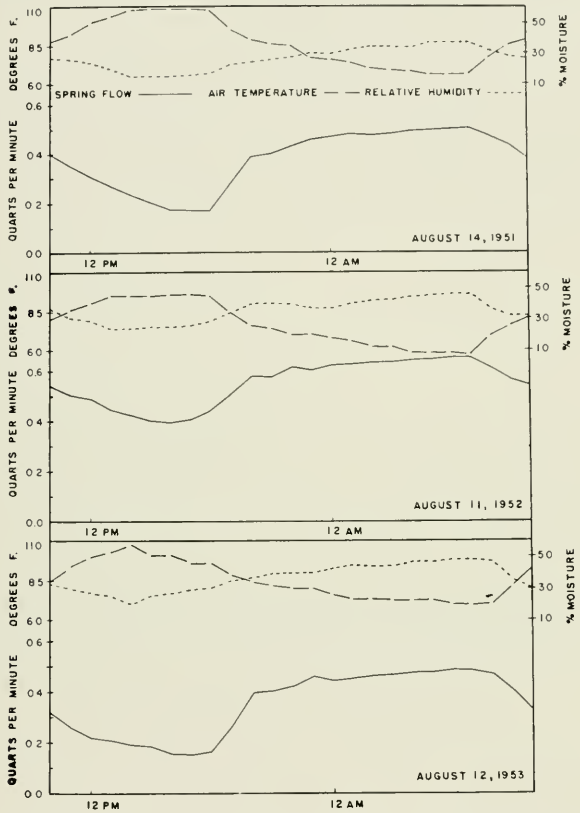

FIGURE 16. Measurements of spring flow, air temperature, and relative humidity at Willow Spring for a 24-hour period for each of three years as the sprouts recovered in growth.

TABLE 2

Flow Data for Willow Spring Showing Use of Water by Willows

Year	Gallons per day			Average temperature	Average relative humidity
	Potential flow	Actual flow	Water used		
1951	188	144	44	84	29
1952	232	191	41	77	34
1953	176	124	52	80	38

The willows were cut a second time on August 20, 1953. The trend in flow before and after cutting is shown in Figure 17. The difference in flow for 24 hours before cutting and for 24 hours after cutting amounted to 63 gallons. This is 21 percent greater than the amount shown in Table 2. The flow continued to increase for the remainder of the season as it did in 1950, indicating again that the willows were using considerably more water than the amount calculated by subtracting the flow the day after from the day before cutting.

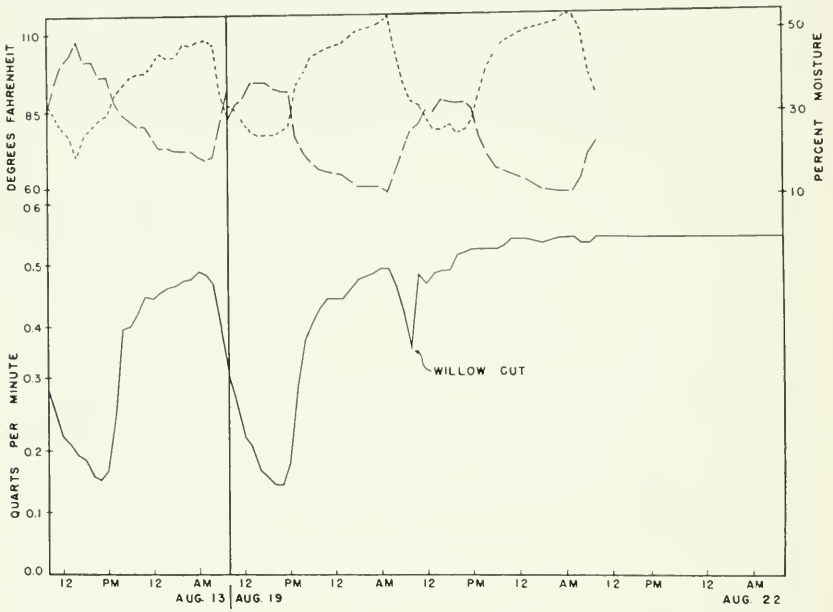

FIGURE 17. Measurements of spring flow, air temperature, and relative humidity at Willow Spring before and after recutting willows in 1953

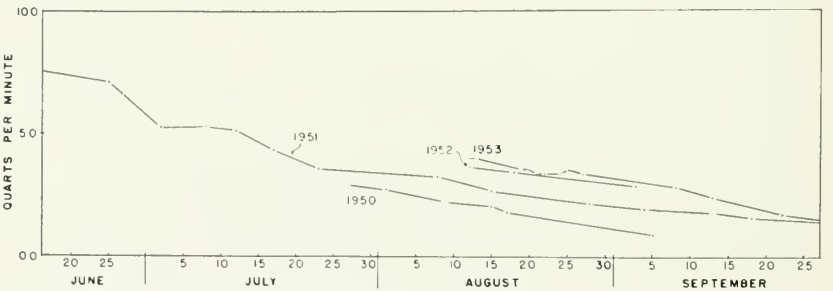

FIGURE 18. Trend in flow of Buckeye Spring for each year of study. This served as a check to Willow Spring. Rainfall at the nearest station (Lakeport) was as follows: Season 1949-50, 21.9 inches; 1950-51, 34.3 inches; 1951-52, 36.7 inches; 1952-53, 31.1 inches.

Buckeye Spring

This spring was located about one-half mile from Willow Spring and served as a check. The surrounding area was open except for one manzanita bush and a buckeye tree nearby. Leaves of the buckeye began to dry about mid-July.

The trend in flow for this spring was downward for each of the four summer seasons, as indicated in Figure 18.

DISCUSSION

Springs are an important source of water in California for game and livestock and for domestic use. Just how plant-cover manipulation effects them has been studied but little. The results here indicate that in some cases the flow might be increased markedly by removing or changing plant cover. California is a good place for studies of this sort because of the long summer period when there is no precipitation to complicate matters.

Every spring is different. There are differences in size of watershed, plant species and density of cover on the watershed, type of soil, geological formation, whether or not the spring is shallow or deep seated, and source of water. For some springs the water supply may come from outside of the local watershed.

Where the spring water is dependent on the local watershed, it is not unreasonable to expect some increase in flow as a result of manipulation of the plant cover. Several principles are involved (8, 9, 16). One of these is changing from deep-rooted species, such as shrubs and trees to more shallow-rooted species, such as grasses and shallow-rooted forbs. In this case the moisture left in the soil below the depth of the shallow-rooted species is then available for spring flow. This change in plant cover becomes more significant where the grasses and forbs are annuals and are not using water during the summer. This was probably the case with Rock Spring which flowed water all summer long after the conversion from brush and trees to more shallow-rooted annual grasses and forbs.

Studies by the California Forest and Range Experiment Station showed that the soils under shrubs and pines, lost all the available moisture to evapo-transpiration during each summer dry season, whereas, under grass 10 inches of water remained in the soil (3). This was determined by the use of lysimeters extending down six feet. Field studies also showed important differences in evapo-transpiration loss from deep soils covered with oakbrush and annual grass (4). The field plots were originally covered with dense scrub oak and other native brush, and in the winter of 1951-52 two sets of plots were converted to annual ryegrass. The soil of the undisturbed brush plots was wet to field capacity throughout the 12-foot depth during the first winter, when rain totaled 41 inches. But during the next three winters rainfall was only 12, 25, and 20 inches, and the soil was wet to field capacity to depths of only 4, 10, and 4.5 feet. Each summer evapo-transpiration dried the entire soil of these plots to near or below wilting point, and rain was insufficient after the first year to rewet it fully.

In the plots converted from brush to grass the story was different. Here, the soil was wet to field capacity through its entire depth each winter season. During summers the soil dried below field capacity to an average depth of only 7 feet and below wilting point to an average depth of 3.2 feet. Consequently, below the 4 foot depth under the grass, there was a greater carry-over of water at the end of each summer than there was in the brush where there was none. Thus, it may be seen that with low rainfall a grass-covered soil would be more likely to produce spring water than a brush-covered soil where other things are equal. In somewhat similar studies Veihmeyer and Johnston (14) showed a savings in water of two inches after converting from brush to grass. Young and Blaney (18) also point out the differences in water use by native brush and grasses in southern California studies.

In our studies roots of grasses, shrubs, and trees were excavated in the field to determine rooting depth. Soft chess (*Bromus mollis*) was found to penetrate the soil to a depth of 39 inches, and foxtail fescue (*Festuca megalura*) to 23 inches. Both of these annual grasses are important components of the resident vegetation. Ryegrass, an annual commonly planted in this area on burned-over brushlands, extended its roots to 42 inches. In other studies this species penetrated to 54 inches (12). Tarweed is deeper rooted than the grasses and during those years when abundant it depletes the soil moisture to a greater depth than the grasses.

Roots of three five-year-old buckbrush plants were excavated and all were found to extend to a depth greater than 10 feet. The roots of 11-year-old ponderosa pine (*Pinus ponderosa*) were traced down 12 feet but they went much farther, as indicated by the size of the root at the 12-foot depth. Hellmers *et al.* (6) in Southern California found California scrub oak to extend down 28 feet, canyon live oak 24 feet, and chamise 25 feet. In Texas, mesquite roots were found below 60 feet (2), and in the Suez Canal area salt cedar was down 90 feet (5).

A second principle concerned with plant-cover manipulation and spring flow involves plants that have their roots in free water. When the tops of such plants are removed, more water may immediately become available for spring or creek flow. A common example is stream bed vegetation. The roots of these plants may not necessarily be deep but neither may the water table. Less well-known is how upland plants tap free water. The excavations of buckbrush give some indication of this. As mentioned above, the roots of three of these plants extended to 10 feet where they reached granite and were beginning to grow horizontally. At this level they were in water flowing over bed rock. This was on April 29, 1952. Thus, in addition to the water removed from the soil it seems that these deeply rooted plants can sometimes tap underground flows of water. This may be important as far as increase in spring flow immediately after brush removal is concerned. When the tops—transpiration surface—are removed by burning or cutting this water is then permitted to enter spring flow. This principle, we think, accounts for the quick increase in flow in Finegold Creek, Willow Spring, Grapevine Spring, and possibly in the others except Rock Spring. High rates of flow might be maintained permanently where the vegetation is nonsprouting; on the other hand, regrowth of sprouts may gradually decrease spring flow to its former status.

A third principle that might apply in plant-cover manipulation and spring flow concerns infiltration capacity. If the infiltration should be lowered to the point where most of the precipitation is dissipated through surface runoff and is not permitted to enter the soil, then spring spring flow might decrease or the springs might even go dry. This could result from creation of bare soil that becomes sealed. This situation was not encountered in these studies.

The objective in range and wildlife management should be to maintain high infiltration capacity so water will go into the soil. This will automatically increase forage and will give the greatest yield of water through spring and creek flow.

SUMMARY

Quantitative measurements were made of the effects of brush removal and manipulation on spring and creek flow. In some cases the brush and trees were top-killed by control burning and the areas converted to grassland, in others the woody plants around springs were cut with an axe. Increases in flow resulted from these operations, in most cases almost immediately.

The amount of increase in spring flow that one could expect would vary considerably, depending on such factors as the size of the watershed, density and kind of plants on the watershed, type and depth of soil, geologic formation, amount of rainfall, and source of water.

Three principles govern spring and stream flow changes resulting from plant-cover manipulations: (1) conversion from deep-rooted species, trees and shrubs, to shallow-rooted species, grass, makes the water in the deeper zones—below the grass roots—available for spring flow. (In our studies the conversions were largely to annuals which are dry during the summer months); (2) removal of transpiring surface of plants whose roots are in free water results in immediate increases in spring and stream flow; (3) practices which decrease the infiltration capacity of the soil resulting in high surface runoff may retard spring flow or stop it altogether.

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CALIFORNIA'S FIRST GENERAL EITHER-SEX DEER HUNTING SEASON[1]

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INTRODUCTION

In 1956, California held its first general either-sex deer hunting season. The area opened to either-sex deer hunting embraced 34 out of the 58 counties in the State. All hunters who possessed a "B" deer tag were allowed to use it for taking one deer of either-sex during the last three days of: (1) the early coastal deer season—August 4th to September 16th; or (2) the late deer season—September 22d to October 28th.

The area of deer range in the coastal either-sex deer season included about 10 million acres in 17 counties. According to a statewide survey, made for the Department of Fish and Game by the University of California in 1948-1950, this area contains a population of around 210,000 deer. (Longhurst, Leopold and Dasmann, 1952). However, private land makes up much of the range and hunting on it is quite limited. The total reported take of deer from the coastal either-sex season area was 14,151 legal bucks and 5,747 antlerless deer. This makes an estimated harvest of 9.5 percent of the total deer population.

The late either-sex deer season area included all or portions of 18 different counties. This area embraced about 17 million acres of deer range with a population of deer estimated at 340,000 head. A considerable fraction of this acreage is made up of National Forest or Taylor grazing lands open to public hunting. The total reported take of deer from this late season area was 30,423 legal bucks and 32,334 antlerless deer. This makes an estimated harvest of 18.5 percent of the total deer population.

This paper has been written: (1) to present a brief history of the events that led up to the ordering of this first general either-sex deer season; (2) to give a breakdown of the deer kill by regions; (3) to consider the problems that arose during and after the hunt; and (4) to evaluate the effect of the 1956 antlerless deer harvest on the 1957 buck bag.

BACKGROUND OF THE EITHER-SEX HUNTS

The either-sex deer seasons in 1956 resulted from a series of investigations, recommendations, and policy decisions that extend back over a period of 11 years.

[1] Submitted for publication January, 1958. Part of the work on which this report is based was done by Federal Aid in Wildlife Restoration Project California W-51-R, "Big Game Investigations."

Some indication of the magnitude of the deer problem in California was given by a preliminary survey of deer ranges in 1946 and 1947. This survey revealed that conditions on 37 out of 71 deer ranges examined were critical for deer. The findings of the Devil's Garden Interstate Deer Herd Committee in Modoc County (organized in 1945) and of the Jawbone deer herd investigation in Tuolumne County, carried on by the University of California (1947-1951), revealed the extent of the depletion of range and waste of deer that occurs when deer populations become out of balance with their habitats. These findings were corroborated by later work of the Lassen-Washoe and Carson-Walker Interstate Deer Herd Committees and of investigations on many other deer ranges in California.

A survey of California deer herds, their ranges, and management problems, made by the University of California for the department during the period 1947-1951, found that practically all California deer ranges were fully stocked (op cit.). It was reported that many ranges were overstocked by the 1940's, and that common manifestations of overstocking were: (1) periodic starvation losses; (2) periodic disease epizootics; (3) overbrowsed and deteriorating ranges; (4) increased agricultural and garden damage; and (5) reduced productivity in deer herds. The university reported that the era of deer "restoration" is over. The present need is to harvest a maximum annual crop of deer from existing breeding populations. To accomplish this it is necessary to harvest two or three times the present kill (estimated to be 75,000 bucks) by allowing the taking of does, as well as of more bucks through the opening of obsolete refuges and holding slightly later deer seasons.

In 1949, the Wildlife Conservation Board brought in Dr. D. I. Rasmussen, a recognized authority on big game management from Utah, to inspect representative sections of deer range in California. Dr. Rasmussen concurred with the findings of the University of California, and with department investigators, that there was a need for greater harvests of deer in order to use the resource properly and to insure its maintenance.

As a result of the findings of these various investigations, the California Fish and Game Commission, after statewide discussion and approval by sportsmen, ranchers, conservation agencies, and other interested parties, adopted a deer management policy for California in June, 1950. The objectives of this policy may be summarized as the production and maintenance of a maximum breeding stock of deer on wild lands of California consistent with range carrying capacities and other uses of such lands, and the utilization through public hunting of the available crop of surplus deer of either sex produced annually by this breeding stock.

Meanwhile, the first antlerless deer hunt had been held during a special season on Catalina Island during the winter of 1949-1950, with a take of 477 animals. This was followed by the first special antlerless deer hunts held on the mainland when 677 deer of both sexes were taken from the Mineral King Refuge in Tulare County, and 1,319 antlerless deer from the Devil's Garden in Modoc County, during the fall of 1950.

As the recognition of deer problems became more general, additional special antlerless and either-sex deer seasons were ordered by the commission. Starting with the Catalina hunt, there have been 37 such hunts with results shown in Table 1.

TABLE 1

Special Hunts in California Through the 1955-56 License Year

License year	Number of hunts	Reported kill
1949-1950	One	477
1950-1951	Two	1,996
1951-1952	Four	3,225
1952-1953	Five*	1,932
1953-1954	Four	814
1954-1955	Eight	2,135
1955-1956	Thirteen	9,459

* Kill figures were not obtainable from one of these hunts.

This adds to a total of 20,038 deer reported taken during 37 special hunts up to the end of the 1955-56 license year (June 30th).

A majority of people interested in deer in this State have become aware of the fundamental concepts of deer management during recent years due to considerable publicity on the subject.

By law, special hunts in California have been based on serious need to correct problems of agricultural or range damage or of population surpluses. The experience in many other states, as well as of limited investigations here, have indicated that either-sex hunts are a needed year-to-year harvest practice.

The most significant trend in deer management throughout the Nation during the last 15 years has been the shift in concept of either-sex deer hunting from a damage to a harvest basis. Present thinking recognizes the need to keep deer herds at optimum population levels at which the animals have all they need in order to flourish. It recognizes that this can only be done by removing annual surpluses, both male and female, each hunting season. It aims at prevention of range damage. Experience has shown that properly stocked ranges result in healthier animals in better condition, improved fawn production and general survival.

As the public recognized the need for deer harvests to correct local problems and recognized that many other states were hunting deer of either sex as a general practice, the demand that localized controlled special hunts be replaced with a more easily administered general either-sex deer season arose.

At the April, 1956, meeting of the commission, when recommendations for seasons and bag limits were heard from the public, a large number of individuals and organizations went on record in favor of either-sex deer hunting. While some of these recommendations varied as to length of season or method of tagging, a total of 18 unsolicited resolutions, signed by 2,811 individuals, favored hunting deer of either sex as did 49 organizations (see Appendix 1).

Because of the public demand for a reduction of restrictions in antlerless deer hunting, and the successful regulation of either-sex deer

hunting by length of season in other states, as opposed to the unit quota system, the department recommended that a number of designated counties be open to either-sex deer hunting during the last three days of the regular buck seasons on a trial basis. After lengthy discussions and public hearings the either-sex hunts were ordered by the Fish and Game Commission. The counties included in the area open to such hunting are shown in Figure 1 (listed in Appendix II).

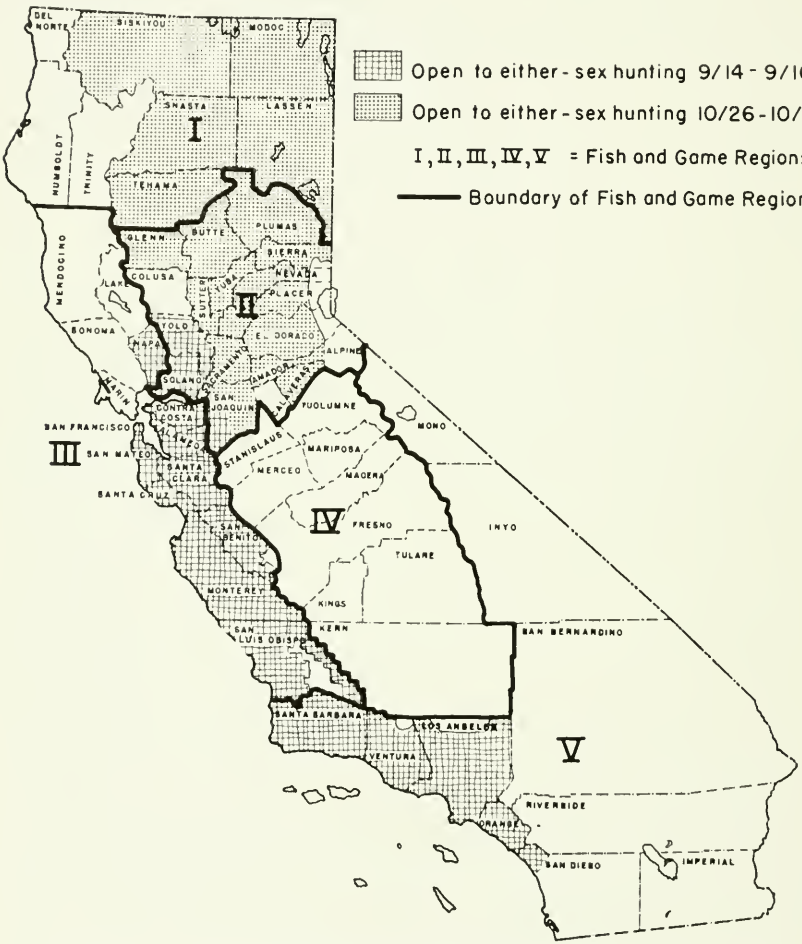

FIGURE 1. Map showing areas open to either-sex deer hunting during the regular season of 1956. Prepared by Cliffa Corson.

When the hunting regulations were being considered it was pointed out that the experience gained from the 1956 hunts could serve as a guide in the future as to whether to allow longer or shorter general either-sex deer seasons, or go to a quota system where needed to limit the number of hunters or to control the kill of deer.

THE REPORTED DEER KILL

The final tabulation of the reported deer kill for counties open to either-sex deer hunting during the early and the late deer seasons is given in Table 2.

TABLE 2

Total 1956 Deer Kill by Areas and Seasons

	Bucks (2 points or more)	Antlerless deer (spike bucks, does, fawns)	Total deer
Early season	14,151 (71 percent)	5,747 (29 percent)	19,898 (100 percent)
Late season	30,423 (48 percent)	32,334 (52 percent)	62,757 (100 percent)
Either-sex area	44,574 (54 percent)	38,081 (46 percent)	82,655 (100 percent)
Statewide total	70,371 (65 percent)	38,081 (35 percent)	108,452 (100 percent)

The Early Season

During the early deer season, bucks with two points or more made up 71 percent of the bag in the counties open to either-sex deer hunting, while antlerless deer made up 29 percent of the bag. When the rather low take of antlerless deer is compared with the estimated deer population of the open area it is apparent that the antlerless deer kill amounts to little more than a token harvest, less than 3 percent of the estimated deer population.

It is admitted, however, that much of the land included in the early either-sex season was either closed to all hunting or open to a limited number of hunters. Hence the antlerless kill came from an acreage and a deer population smaller than the totals given above. The acreage of such closures is subject to annual fluctuation and is not known. However, if even as much as three-quarters of the 10 million acres with its estimated deer population of 210,000 animals contributed little or nothing to the bag, the antlerless kill of 5,747 deer would still be quite conservative.

The Late Season

The antlerless deer bag taken during the late deer season totaled 32,334, a more substantial harvest. Here the antlerless deer kill amounted to 9.5 percent of the estimated deer population, and was slightly greater than the total reported buck kill. In the late season, the percentage take was closer to that commonly taken year after year in states that regularly hunt deer of either sex.

Composition of the Antlerless Deer Bag

About 20 percent of the total antlerless deer taken during the early season were examined and classified by department personnel in the field. The composition of the antlerless deer bag for the early either-sex deer season as indicated by these bag checks is given in Table 3. It will be seen that the bag was composed of 69 percent does, 10 percent spike bucks, and 21 percent fawns.

The bag check data summarized in Table 3 may be compared with the classification of the kill made by the hunters themselves as listed on kill report cards. The antlerless kill was classified by hunters as follows:

Does	3,156	(65 percent)
Spike bucks	771	(16 percent)
Fawns	909	(19 percent)
Subtotal	4,838	(100 percent)
Age or sex not given	911	
Total	5,747	

It will be noted that the percentage of spike bucks reported by hunters is higher than indicated by checks of the bag in the field. This may have resulted from misclassification by hunters of this year's fawns with small spikes as "spike bucks." It also appears that the hunters may have misclassified some yearling does as fawns. A breakdown of the reported kill by counties will be found in Table 5.

TABLE 3

Percentage Composition of the Antlerless Deer Bag
(Early season)

Area	Does	Spike bucks	Fawns	Number deer checked
Yolo County	70	11	19	57
Napa County	84	8	8	66
Santa Cruz County	81	15	4	27
San Benito County	70	18	12	17
Monterey County	67	16	17	166
San Luis Obispo County	69	13	18	136
Santa Barbara-Ventura Counties	62	11	27	286
Los Angeles County	71	5	24	293

Averages by regions

Area	Does	Spike bucks	Fawns	Number deer checked
Region II	70	11	19	57
Region III	73	12	15	427
Region V	66	8	26	543
Average	69	10	21	1,027

During the late either-sex deer season, checks at established checking stations and by roving field personnel resulted in the examination and classification of 7,321 animals, or over 20 percent of the reported antlerless kill. The results of these checks are given in Table 4. The percentage fawn kill appears to have been higher in Region II than in Region I. If a comparison is made by areas it will be seen that the fawn kill was considerably higher percentage-wise in some areas in both regions than it was in others.

TABLE 4

Percentage Composition of the Antlerless Deer Bag
(Late season)

Area	Does	Spike bucks	Fawns	Number deer checked
Management units, Region I				
Warner Mountains	78	6	16	1,883
Devil's Garden	73	3	24	1,510
Doyle	70	6	24	1,167
Siskiyou	79	5	16	586
Shasta	75	8	17	134
Tehama	70	9	21	525
Region-wide average	74	6	20	5,795
Checking stations, Region II				
Inspiration Point, Amador Co.	64	6	30	92
Calaveras RS., Calaveras Co.	68	4	28	524
Elk Creek, Glenn Co.	78	12	10	68
Webber Lake, Sierra Co.	64	6	30	56
Sierraville, Sierra Co.	68	4	28	227
Taylorsville, Plumas Co.	66	4	30	128
El Dorado Co.	78	11	11	152
Nevada Co.	69	13	18	251
Placer Co.	86	0	14	28
Region-wide average	69	7	24	1,526
Overall average	73	6	21	7,321

Antlerless deer tags for the late either-sex hunt were classified by the reporting hunters as follows:

Does	20,557	(73 percent)
Spike bucks	2,565	(9 percent)
Fawns	4,903	(18 percent)
Subtotal	28,025	(100 percent)
Age or sex not given	4,309	
Total	32,334	

A breakdown by counties is given in Table 6.

Here, again, hunters reported taking more spike bucks and less fawns than is indicated by bag checks. Again, this is probably the result of misclassification of male fawns with small spikes as "spike bucks."

PROBLEMS RELATED TO EITHER-SEX HUNTS

Fawns

It has been common experience in states allowing either-sex deer hunting for the first time, that the taking of fawns arouses considerable public reaction. This is understandable in view of the sentimental values involved. So much sentimental stress has been placed on protection of fawns over so long a period, that many persons, who think nothing of the age or sex of the veal or lamb they eat regularly, are apt to become disturbed about the harvest of fawns. This proved to be true, particularly in areas where no special antlerless deer hunts

TABLE 5

Composition 1956 Either-sex Deer Season—Coastal

(Figures used are only for counties in which either-sex hunting was permitted)

County of kill	Male			Female			Sex not given			Total		
	Spikes	Fawns	Age NG*	Adult	Fawn	Age NG*	Adult	Fawn	Age NG*	Antlerless	Bucks forked-horn or better	Total deer
Alameda	8	1	1	27	3	4		1		45	538	583
Contra Costa	20	8	5	45	5	5	--	1		89	187	276
Los Angeles	116	124	43	713	121	147	9	19	9	1,301	1,112	2,413
Monterey	145	46	26	413	57	115	8	8	1	819	2,585	3,401
Napa	41	31	16	291	21	49	8	3	1	461	1,144	1,605
Orange	11	6	5	50	2	15	4			93	181	274
San Benito	23	9	6	82	7	31	6	1	--	165	1,233	1,398
San Diego	1	3	1	24	2	1	--	--	--	32	179	211
San Joaquin		--	--	1	--	--	--	--	--	1	49	50
San Luis Obispo	136	40	27	377	43	85	4	12	--	724	2,222	2,946
San Mateo	9	2	3	22	7	7	--	--	--	50	134	184
Santa Barbara	100	54	11	398	57	51	8	6	--	685	1,571	2,256
Santa Clara	20	8	5	61	4	22	3	--	--	123	1,239	1,362
Santa Cruz	27	9	5	60	3	16	2	3	--	125	202	327
Solano	4	3	6	33	3	15	3	1	--	68	147	215
Ventura	98	79	20	485	69	82	2	9	3	847	1,138	1,985
Yolo	8	8	2	62	8	7	1	1	--	97	275	372
Not given	4	--	--	12	--	5	--	1	--	22	15	37
Total	771	431	182	3,156	412	657	58	66	14	5,747	14,151	19,898
Composition of either-sex kill by percent	13.4	7.5	3.2	55.0	7.2	11.4	1.0	1.1	0.2	100.0	--	--
Composition of either-sex and buck deer kill in above counties only	3.9	2.2	0.9	15.8	2.1	3.3	0.3	0.3	0.1	(28.9)	71.1	100.0

* NG—not given.

TABLE 6

Composition 1956 Either-sex Deer Season—Inland

(Figures used are only for counties in which either-sex hunting was permitted)

County of kill	Male			Female			Sex not given			Total		
	Spikes	Fawns	Age NG*	Adult	Fawn	Age NG*	Adult	Fawn	Age NG*	Antlerless	Bucks forked-horn or better	Total deer
Amador	46	34	12	247	46	47	6	4	1	443	407	850
Butte	105	83	29	583	75	107	14	7	1	1,004	1,152	2,156
Calaveras	91	135	13	759	108	86	12	10	7	1,221	601	1,822
El Dorado	201	117	46	959	93	208	20	15	3	1,662	1,437	3,099
Glenn	89	68	17	429	67	43	6	6	1	726	859	1,585
Lassen	364	460	122	3,509	389	517	66	41	20	5,488	4,086	9,574
Modoc	382	489	64	4,349	447	376	34	17	12	6,170	4,817	10,987
Nevada	100	31	24	379	49	88	8	11	3	693	937	1,630
Placer	35	26	12	231	18	40	4	2	1	369	741	1,110
Plumas	142	196	70	1,545	208	235	27	16	11	2,450	1,915	4,365
Sacramento	4	1	--	16	--	8	1	--	--	30	34	64
San Joaquin	--	--	--	2	--	--	--	--	--	2	4	6
Shasta	209	182	81	1,764	142	307	38	20	5	2,748	3,415	6,163
Sierra	67	102	24	679	106	104	18	12	--	1,112	782	1,894
Siskiyou	342	227	54	2,704	237	371	40	20	17	4,012	5,651	9,663
Sutter	--	--	--	1	--	--	--	--	--	1	3	4
Tehama	358	253	140	2,223	243	510	61	41	31	3,860	3,116	6,976
Yuba	20	18	6	125	13	51	4	4	--	241	323	564
Not given	14	5	--	55	6	19	--	3	--	102	143	245
Total	2,565	2,427	718	20,557	2,247	3,116	362	229	113	32,334	30,423	62,757
Composition of either-sex kill by percent	7.9	7.5	2.2	63.6	6.9	9.6	1.1	0.7	0.4	100.0	--	--
Composition of either-sex and buck deer kill in above counties only	4.1	3.9	1.1	32.8	3.6	5.0	0.6	0.3	0.2	(51.5)	48.5	100.0

* NG—not given.

have been held in the past. In such areas many people who were exposed to doe and fawn hunting for the first time were naturally disturbed.

The huge loss and waste of fawns which occurs each year as a result of unbalance between deer and range goes unnoticed by the public because it is unseen. Investigations made by the department have revealed that such losses are often staggering, since fawns are the first to suffer when shortages of food, water, cover, or other necessities occur. The harvest of a percentage of the fawns during either-sex deer seasons must be considered a normal and beneficial practice. About 24 percent of the total annual deer kill in Maine, a state that has always allowed the taking of any deer, is made up of fawns. The balance of the bag of deer of yearling age or older is composed of 60 percent bucks and 40 percent does. Bag checks in Wisconsin indicates that fawns made up 28 percent of the total deer kill in 1950 and 43 percent in 1951 during either-sex deer seasons. On the Minidoka National Forest in Utah, the sustained take of deer over an 11-year period averaged 51 percent bucks, 39 percent does, and 10 percent fawns, without damage to the herd.

The percentage of fawns in both the early and late season deer kill was somewhat lower than is commonly the case elsewhere.

The question of survival of orphaned fawns has aroused concern in some areas. Fawns are weaned at 60-90 days of age and can care for themselves after weaning. Fawn survival has not been reported as a problem in states which regularly hunt deer of either sex. The best example of this sort in this State occurred on the Mineral King area in Tulare County. Here, a special either-sex deer hunt was held from September 16 to October 15, 1950. When the next special hunt was held on this area in 1955, it was found that the second highest percentage of animals over yearling age in the kill was made up of the animals born in 1950 despite the fact that the 1950 hunt began in mid-September. The highest percentage of animals over yearling age in the 1955 kill was made up of the fawn class of 1951.

Hunter Distribution

The problem of hunter distribution has been an important consideration of the commission and department for some time. For several years the commission has denied the request that the deer season in Southern California be changed from the regular August-September and September-October periods to a December-January period. The prime reason for denying this request has been realization of the danger of opening too small an area to hunting by the general public without some restriction on the distribution of hunters. One winter hunt was held in January, 1954, on a special hunt basis.

Although a considerable majority of the interested public favored a three-day either-sex deer season in Central California in 1955, the commission wisely decided not to order this hunt because of the danger of concentrating too many hunters in a limited territory. Prior to 1957, the commission did not have the power to regulate the number of hunters by areas except during special hunts under permit.

As it turned out, during the early either-sex deer season, hunter pressure was light to moderate, and few distribution problems occurred, except on certain areas in Southern California. Region 11 reported that

hunting pressure in the coastal portion was considerably below that common on the opening weekend of buck season. The only area where pressure approached that on opening weekend was Solano County, and here no great number of hunters or crowding was involved.

Region III reported that hunting pressure was much lighter than that common on opening weekend. Pressure in the popular Knoxville area in Napa County was less than half that usually occurring on opening weekend.

Region V reported that pressure varied in different areas, but the estimate was about 50 percent of the number of hunters usually present during the buck season opening. The only area in which crowding was reported was the Big Pines area of the Angeles National Forest and, to a lesser extent, the Big Pine Mountain area in Ventura County.

This favorable pattern did not hold during the October either-sex deer season. Evidently many persons waited to use their "B"[2] deer tags during the late season. With the advent of storms toward the end of the season, and the spread of news that deer herds were in migration, large numbers of hunters moved into the field for the last days of the season; some to hunt primarily for big bucks, many others to take antlerless deer. These hunters tended to concentrate in better known and favorite late season hunting areas, such as the Paynes Creek area in Tehama County and the Blue Mountain area in Modoc County.

There was a definite distribution problem in some areas. The high range in the Sierra was covered with snow, and this resulted in the appearance of more hunters than usual at lower elevations in some places. Had hunters been better spread over the open area, distribution problems would have been less serious. There were large acreages of open hunting territory on which hunting was light. But hunters tended to concentrate: (1) in favorite late season buck hunting areas; and (2) areas known for good hunting because of previous special antlerless deer hunts.

It should be remembered that storms which start deer into migration always bring out large numbers of buck hunters to have a last try at a buck before the season closes. The hunters attracted by the chance to take an antlerless animal added to this number. Areas in which concentrations were reported were the Doyle-Last Chance (Plumas-Lassen County), the Sierra Valley (Sierra County), the Blue Mountain (Modoc County), the Paynes Creek-Plum Creek (Tehama County), Ham Station (Amador County), Forest Hill (Placer County), Fall River Mills and Pittville (Shasta County), Calaveras County foothills, and the north Butte-south Tehama County areas. The number of hunters in the Susanville-Westwood area was reported by the state highway patrolman in that district to have been one-third greater than on the opening weekend of buck season.

While it is true that concentrations of hunters that would be considered normal in some parts of the State (viz. Southern California) were reported as dangerously high in other parts of the State because they were unusual there, there is little doubt that some serious crowding occurred. In the Paynes Creek area the problem was especially acute. Here a total of 1,004 cars were parked or moving on an eight-

[2] "B" tags are used for the second buck in a two-deer district or for the one buck in a one-deer district.

mile stretch between the Plum Creek headquarters and Judd Creek on October 27. On a six and one-half mile stretch of road between the Paynes Creek store and the Hogback Road (via the Lyonville Road) 459 cars were parked. There were two to five hunters per car.

While the concentration of hunters was high in some areas, the deer kill on such concentration areas was high but not excessive. For instance, the total antlerless deer kill on the Devil's Garden area in Modoc County during the 1956 either-sex deer hunt was 1,885. This may be compared with a total antlerless kill of 2,008 made the year previous (1955) during a special hunt. During 1956, a total of 3,102 antlerless deer was reported taken from the Lassen-Washoe management unit in Lassen and Plumas Counties, an area from which 1,858 antlerless deer were removed in 1955. In Tehama County, a total of 3,806 antlerless deer was taken during the 1956 either-sex deer season as compared with 2,715 antlerless deer taken during a special hunt in 1955.

The fear of overshooting is a reaction that has happened in every state after the first general doe season. As Dr. A. Starker Leopold, of the University of California, points out, "the danger of overshooting is more hypothetical than real. It remains a fact that in all the legal doe shoots that have been held in the United States in the past 20 years, there has never come to light an authentic case of serious overshooting of a herd. The surviving population has an astonishing way of bouncing back and filling the vacuum left by the hunting * * * . The best reassurance to hunters that the herds are not being hurt will come next year when they go back and find (usually to their surprise) that there is still a good stock of deer in the country."

The real problem in hunter concentration is the danger to life and property, as well as the adverse public reaction, that results from such situations. After a full evaluation of information derived from the two either-sex deer seasons, it appears that there is definite need to use a unit-quota system in some areas, while in other parts of the state regulation of such hunting by length of season alone appears to have been proven entirely adequate.

Crippling Loss

Rumors were circulated in some areas that large numbers of dead deer had been left in the field as a result of either-sex deer hunts. Crippling losses during both buck and antlerless deer seasons are often higher than is generally realized. They tend to vary with type of cover and roughness of terrain. An investigation made in Utah several years ago revealed there were fewer deer left in the field in areas where either-sex hunts were held than in areas open to bucks alone. This appears logical enough, when it is remembered that all deer except legal bucks shot during a buck season through carelessness or miscalculation tend to be left, while during either-sex seasons most deer are taken.

For the early either-sex deer season, Region II reported the crippling loss to be about the same usually encountered during the regular buck season. Region III reported the number of dead deer left in the field as considerably less than that which occurs during the opening weekend of buck season. More than 1,000 hunters were contacted. They reported a total of 25 such lost deer seen while hunting. Region V stated that

the usual reports of deer shot and left in the field were noticeably lacking during the early either-sex deer season.

During the late either-sex deer season, Region II questioned hunters regarding dead deer seen left in the field. Around 3,500 hunters were questioned. They reported a total of 14 bucks, 56 does, and 7 fawns seen crippled and 11 bucks, 27 does, and 16 fawns seen dead, during the course of their hunting.

The department investigated reports of dead deer left in the field, and was unable to substantiate them. For instance, a report of 12 to 14 deer carcasses left on a ranch on State Highway 16, Amador County, was received on November 19th. The persons who made the observation were contacted. They admitted that the spot was alongside a road where trash was dumped and that what was seen was bags of heads, hides, feet, and offal of about 14 deer left there shortly after the close of the hunting season. They stated they had seen only one entire animal, but had seen several forequarters. Upon checking the garbage dump on November 20th, no remnants of deer remained.

Rumors of many deer carcasses left at the Redding garbage dump (reportedly the worst case) were investigated, but attendants claimed that the carcasses had been burned. It is believed that rumors of deer left at garbage dumps have been grossly exaggerated and are based primarily upon disposal of offal at such places.

A postseason deer carcass count was made in the Snow Lake-Mount Adams area north of Sierra Valley in Sierra and Plumas Counties. Three men walking abreast 30 to 50 yards apart for approximately six miles, located four deer carcases: one female fawn, one adult doe, one yearling buck, and one unknown. All carcasses were believed to have been dead a year or more. During the process of making deer counts in Sierra Valley in December, 1956, about 20 miles were covered on foot. A total of five fawn carcasses was observed. These animals could have been killed during the deer season.

Four man-days of search in the heavily hunted Doyle area in Lassen County resulted in a count of one dead doe, one crippled doe, and one crippled fawn. A check of losses in the most heavily hunted areas in Siskiyou County resulted in a count of three dead deer in five miles of check strips. One was a doe killed prior to the hunting season, and two were fawns. A carcass search made on the Devil's Garden in Modoc County resulted in finding one fawn carcass during 16 hours of search. No crippled deer were seen in this area when counts were made in December, 1956.

There can be no doubt that a crippling loss did occur, just as it occurs during regular buck seasons. It appears doubtful, however, that it was of more serious magnitude than that which occurs each year.

HUNTER BEHAVIOR

Early Season

During the early either-sex deer season, according to reports received from Region II, there were no reported accidents in that region and little hunter trouble. Of 826 hunters checked, 23 were first-time deer hunters, 52 were occasional hunters, and 751 were regular hunters.

Region III reported that few instances of poor conduct were evident. Most hunters were residents of the county in which they hunted. About two-thirds of the hunters were regular year-to-year hunters, one-fifth were infrequent hunters, and around one out of ten were first-time hunters. Road hunting was comparatively light in all areas except Pope Valley, Napa County, where road hunting was moderate to heavy. Of 1,086 hunters checked, 48 percent hunted on public land, and of these, one-third had hunted the same area earlier during the buck season. Of the 52 percent hunting on privately owned land, two-thirds had hunted on the same ranch earlier in buck season.

Region V reported that the consensus among field men was that the hunt went smoothly. Hunter conduct was good, although there were a considerable number of first-time hunters in the field. Law violations increased over that level usual to the opening of buck season, but most were tag violations. One known accident, in which two persons were wounded, was reported from Santa Barbara County.

Late Season

Considerable numbers of reports regarding trespass, reckless shooting, and road hunting have sprung out of the late either-sex deer season. There can be no doubt that there were grounds for such reports. When large numbers of hunters are in the field during any type of season, such instances will occur, due usually to irresponsible persons making up a small fraction of the total persons abroad.

There was a considerable demand in some areas for deer tags. License agents in Northeastern California reportedly sold out all tags on hand during the latter part of the deer season. Evidently hunters made last minute purchases of tags, possibly for their wives and older children, after reaching deer territory. There were disturbing reports to the effect that tags were being purchased for nonhunting wives and juniors in order to tag deer already killed in the field. Final returns show a 9 percent increase in deer tag sales in 1956, as compared with a 4 percent increase in 1954 and a 3 percent increase in 1955 over the previous year.

In Region II hunters were questioned at checking stations in regard to hunting experience. Of 3,488 hunters contacted, 141 stated they were first-time hunters, 181 said they hunted deer occasionally (one out of three or four years), and 3,166 claimed they were regular year-to-year hunters.

A check of hunters in Siskiyou County showed that 83 percent of the persons hunting deer during the either-sex deer season were regular hunters, 8 percent were occasional hunters, and 9 percent were first-time hunters. However a check of unsuccessful hunters showed 44 percent regular, 38 percent occasional, and 18 percent first-time. Excluding the first-timers, 78 percent of the hunters indicated they had hunted in the same area before for bucks, while 22 percent had hunted in other areas for bucks prior to the either-sex season.

Whenever large numbers of hunters go into the field, casualties occur. This happens every year during the opening days of the deer, pheasant, and waterfowl seasons. The either-sex deer seasons of 1956 added to the casualties that year in that they provided two additional season openings. During the deer hunting season of 1955, a total of 10 fatal and 15 nonfatal hunting accidents were reported. In 1956 casualties

increased to 12 fatal and 27 nonfatal accidents. Of these, one fatality and 12 nonfatalities occurred during the three-day either-sex seasons.

LANDOWNER CO-OPERATION

During the early either-sex season, in Region III, 60 percent of the ranchers who owned deer range and had been issued deer depredation permits allowed deer hunting on their lands. In Region II, 47 percent of the ranchers with depredation permits allowed hunting. Some of the other ranches were not suitable for hunting. A survey made by Murray Doyle, Wildlife Representative on the Bureau of Land Management Grazing Advisory Board, revealed that nearly all ranchers in the Milford-Doyle area opened their lands to hunting during the late either-sex season. John Weber, of the Modoc County Cattlemen's Association, stated that only a few ranchers in the Alturas area had posted lands, and that most of them allowed hunting with permission.

Many large ranches were left closed during the either-sex deer season. Ranchers feared that armies of hunters would arrive to trespass and shoot everything in sight. On the other hand, some landowners who opposed doe hunting closed their lands, and individuals opposed to such hunting placed warning signs on both private and public lands. These actions had the effect of further concentrating hunters on the remaining open lands.

HUNTER ACCEPTANCE OF EITHER-SEX DEER HUNTING

Hunters were questioned at different times during the general open season at checking stations in Region II in regard to their thoughts about either-sex deer hunting with the results given in Table 7.

TABLE 7

Results of Poll in Regard to Either-sex Deer Hunting

Period when poll was taken	Number of hunters		
	Yes	No	Undecided
Opening of early buck season	546	164	20
Opening of late buck season	1,175	714	262
Total and percentage	1,721 (60 percent)	878 (30 percent)	282 (10 percent)
September either-sex season	203	65	38
October either-sex season	2,493	1,004	474
Total and percentage	2,696 (63 percent)	1,069 (25 percent)	512 (12 percent)
Grand total and percentage	4,417 (62 percent)	1,947 (27 percent)	794 (11 percent)

Of the 7,158 hunters questioned, 62 percent favored either-sex deer seasons, 27 percent were opposed, and 11 percent were undecided. It is recognized the sample taken during the either-sex season may be biased due to the fact that persons who decided to partake in the hunt would probably be in favor of either-sex shooting. However, it will be noted

from Table 6 that the percentage in favor during buck season was almost as great.

PUBLIC REACTION TO EITHER-SEX DEER HUNTING

Although the early either-sex deer hunt went off rather smoothly, there was sufficient public reaction in certain quarters to call forth a resolution from the County Supervisors Association of California in late September asking the commission to cancel plans for the October either-sex deer hunt. Had the county supervisors objected prior to the time the original orders were made in May, there is little doubt that the commission would have complied with their wishes. In fact, the reason Colusa and Trinity Counties were dropped from the open area at that time was because their Boards of Supervisors had passed resolutions against the killing of antlerless deer. But, according to California law, areas open to hunting for various game species under the commission's regulatory powers cannot be closed at a later date except in cases where added protection of a species is actually needed. Since the commission had ordered the either-sex seasons because it was convinced that the deer herds involved would be benefited by a heavier harvest, grounds for cancellation of the either-sex deer season were not present and no action was taken.

Within a few days after the close of the late either-sex deer season, the Senate Interim Committee on Fish and Game held public hearings in Plumas, Lassen, Modoc, and Shasta Counties to learn the public reaction to the killing of does and fawns. Most of the people present at the Lassen County, and more especially the Modoc County, hearings appeared to favor sound deer management, including antlerless deer hunting, although many of these persons stressed the need for controlling the number and distribution of hunters. Hunter behavior and crowding during the three-day either-sex hunt were the chief complaints heard at the Lassen and Modoc County hearings. It should be pointed out again that antlerless deer hunting was not new to the people of these counties in that previously there had been three special antlerless deer hunts in the Devil's Garden area of Modoc County and two such antlerless hunts in the Lassen-Washoe area of Lassen and eastern Plumas Counties.

Although the Lassen-Washoe special deer hunts had encompassed the eastern edge of Plumas County, most of the residents of that county had their first sight of antlerless deer hunting during the 1956 either-sex season. The experience was also entirely new to the residents of Shasta and Siskiyou Counties who attended the Shasta County hearing. These persons were greatly disturbed by what they had seen during the recent hunt. The hearings were highly charged with emotion. It appeared to be the consensus of opinion that the killing of does and fawns was criminal and that the deer herds in Plumas, Shasta, and Siskiyou Counties had suffered irreparable damage as a result of the three-day hunt. The either-sex hunt was called a fiasco, and the results were considered a debacle.

The upswell of public indignation against the killing of does and fawns was quite similar to that which has occurred in other states after initial changeovers to either-sex deer hunting. The opposition was

quickly organized and was given wide coverage in newspapers. The echo of the outcry in Northern California soon solidified opposition in most of the State.

Many persons and organizations who had been in favor of either-sex deer hunting now accepted the idea that the hunts had proven to be a bad thing. This organized opposition was felt in the 1957 Session of the California Legislature in the form of legislation relating to deer hunting.

As a result of the laws of 1957, the Fish and Game Commission can no longer order general area-wide either-sex deer seasons such as those of 1956. Antlerless and either-sex deer seasons must now be ordered on the basis of management units, crop damage, or restricted instances of surpluses only. Unit hunts may be for antlerless deer if held during the regular buck seasons, or for deer of either-sex if held at other times of the year. Quotas of hunting permits must be set up for each unit and issued to the public either by drawings or first-come, first-served sale, or a combination of both. In short, California is now definitely committed to a unit-quota system for general antlerless deer hunting. Only bucks may be hunted on a general unrestricted basis. In addition, it is no longer legal in California to take spike bucks or spotted fawns. Spotted fawns are rarely found during the periods when such hunting will be allowed.

THE 1957 DEER HUNTING SEASON RESULTS

Although some people predicted that deer hunting was a thing of the past in the northern counties of California as a result of the either-sex deer hunt, the buck kill during the 1957 deer hunting season did not bear out such beliefs. The total reported kill of bucks taken during the regular deer seasons in 1957 was 65,214, the fourth highest kill on record. This may be compared to the kill of 70,371 bucks for 1956.

It is true that the buck kill was higher in 1956 than in 1957 in all but five of the counties in which either-sex hunting was permitted the year previous, but the 1957 kill was higher than the average (1952-56) in 14 out of the 34 counties involved.

It is true that the effect of the doe harvest of 1956 cannot be completely evaluated until 1958 and 1959, because the fawns that such animals might have produced in 1957 would not have become legal bucks until they had become one or two years of age.

Nevertheless, the buck kill of 1957 clearly dispenses with some of the pessimistic claims. For one thing, the high returns do show that the deer herds were not decimated. Also, bag checks in Sierra and east-side counties have revealed a high percentage of yearling and two-year-old animals in this year's kill, an indication that last year's fawns were abundant and survived well, and that last year's spike yearlings were not wiped out during the 1956 either-sex hunts.

The fact that influences other than the either-sex deer hunts of 1956 affected the buck kill is made evident by the status of the north coast counties. Antlerless deer hunts have never been allowed in Marin, Sonoma, Lake, Mendocino, or Humboldt County. The status of the buck kill in these counties has been as shown in Table 8.

TABLE 8

Status of Buck Kill (Coastal Season)

County	1957	1956	Average 1952-1956
Humboldt	986	1,085	1,134
Mendocino	3,847	4,051	4,503
Lake	1,585	2,030	2,252
Sonoma	1,267	1,303	1,620
Marin	548	707	875
Totals	8,233	9,176	10,384

There are many factors that affect the deer kill in any one year. These are the opening or closing of refuges, the protection or legalizing of forked-horn bucks, and the type of weather that prevails during opening weekends when the greatest number of hunters are in the field, as well as the weather toward the end of the season when many hunters go out for a last chance at a buck. All these factors can result in bringing about a total kill higher or lower than that of the year previous. But the most important single factor affecting any year's buck kill is the survival success of fawns born one or two years previous.

The basis for this statement is information gathered from eastern California deer ranges. Here investigations of problem ranges have been carried on by the Department of Fish and Game for several years.

It has been found that when fawn survival is poor, or fair, or good on several ranges in this area, the chances are high that it will be poor, or fair, or good all over the area. In the light of this finding, the buck kill for counties that lay in whole or in part east of the Sierra Crest (Table 9) were compiled for the last eight years and compared with accumulated fawn survival information (Table 10). The result is shown in Table 11.

TABLE 9

Buck Kill by Counties (1950-1957)

County	1950	1951	1952	1953	1954	1955	1956	1957
Modoc	2,330	6,077	1,794	1,076	2,151	2,535	4,817	1,034
Lassen	2,243	4,499	1,962	1,519	2,643	3,366	4,086	3,252
Siskiyou	2,842	4,035	2,187	2,768	4,036	4,220	5,651	1,396
Totals	7,415	14,611	5,943	5,363	8,830	10,121	14,554	11,682
Plumas	1,820	2,255	1,671	2,285	2,763	2,543	1,915	1,720
Nevada	939	1,327	972	1,217	1,750	1,119	937	872
Sierra	947	1,126	795	1,032	1,322	1,011	782	702
Alpine	1,306	1,755	1,442	1,638	1,765	1,896	1,318	1,163
Mono	1,494	1,973	795	2,098	2,565	1,899	1,373	2,237
Inyo	302	718	308	593	606	493	486	564
Totals	6,808	9,154	6,465	8,923	10,770	8,991	6,811	7,258

TABLE 10

Number of Fawns per 100 Does Surviving Until Spring (Eastern California Ranges)

Area	1950	1951	1952	1953	1954	1955	1956	1957
North Warners				35	86	53	50	
South Warners				56	74	36	32	
East Warners								68
West Warners								77
Devil's Garden			34		69	71	63	70
Lassen-Washoe	12	48	29	64	71	46	42	76
Verdi						72	48	69
Carson River				43	67	63	35	70
Walker River			44	50	54	35	34	64
Buttermilk			43	48	48	46	26	57
Goodale Creek			30	39	32	31	17	41
Tunawee Canyon			12	29	55	35	18	39
Average			32	46	62	49	37	63

TABLE 11

Comparison of Fawn Survival With Subsequent Buck Kill

Year	Fawns per 100 does (spring counts)	Total buck kill (eastern counties*)	Statewide buck kill
1950	(poor)	6,808	47,128
1951	(fair)	9,154	64,169
1952	32 (poor)	6,465	50,667
1953	46 (fair)	8,923	58,992
1954	62 (good)	10,770	75,602
1955	49 (fair)	8,994	71,126
1956	37 (poor)	6,811	70,371
1957	63 (good)	7,258	65,214

* Except Modoc, Lassen, and Siskiyou.

The 1957 kill appears to have been affected by the poor survival of the 1954 and 1955 class of fawns. The good survival of the 1956 class (as shown by counts in the spring of 1957) apparently was not enough to offset the accumulated deficit.

The kills from Lassen, Modoc, and Siskiyou Counties are not included in the totals given above because of the influence of the forked-horn law on the take in these counties. Forked-horn bucks were protected up to 1951, at which time the season was opened for two years. The forked-horn was again protected during the three-year period 1953-55. It was made a legal target again in 1956. The records show that the high total kill in these counties in 1951 and 1956 was in great part a result of the bagging of an accumulation of two-, three-, four-year and older previously protected forked-horn deer.

The close relationships of deer kill to fawn survival not only appears to apply to the eastern counties in which the doe:fawn counts were made, but also to a lesser extent to the statewide deer kill. This is an indication that the influences producing poor to good deer survival and buck kills in any one year are of a broad nature. As deer managers accumulate information on deer from other sections of California, the picture may be developed more fully and with more confidence.

SUMMARY

California's first general either-sex deer hunting seasons in 1956 resulted in a harvest of 38,081 antlerless deer from all or portions of 34 counties. This represents 35 percent of the statewide kill of 108,452 deer. In the counties involved in these two three-day seasons, the antlerless kill made up 46 percent of the total kill of those counties.

The full impact of the either-sex seasons will not be felt until the 1958 and 1959 seasons, since most of the fawn production of the surviving does will not become legal targets until those seasons. However, the 1957 buck kill of 65,214 was close to the 1952-56 average bag of 66,129, and the subsequent fawn production and survival have been very high. The indication is that no deer herd suffered from the effects of the either-sex seasons.

Hunter distribution, as a safety factor, did produce a serious problem in certain areas. This cannot all be charged to the either-sex season for early storms started deer on migration. Many hunters went to known migration areas in an attempt to bag a large buck. The conclusion was, however, that general either-sex seasons are a good management tool, especially in the Coast Range agricultural areas. In the balance of the state unit-quota hunts are indicated for the reason of safety to life and property.

REFERENCE

Loughurst, William A., A. Starker Leopold and Raymond Dasmann
1952. A survey of California deer herds, their ranges and management problems. Calif. Dept. of Fish and Game, Game Bull. No. 6, 136 p.

APPENDIX I

List of organizations recorded as favoring the hunting of deer of either sex during 1956:

1. Angwin Chamber of Commerce
2. Bieber Chamber of Commerce
3. Bitterwater Soil Conservation District
4. Butte County Farm Bureau
5. Calaveras Sportsmen's Club
6. California Hunters, Inc.
7. California Farm Bureau Federation
8. California Wildlife Federation
9. Cloverdale Farm Center
10. Cloverdale Farm Bureau
11. Cuyama Valley Sportsmen's Association
12. Escondido Fish and Game Association
13. Fontana Sportsmen
14. Forest Hill Rod and Gun Club
15. Game Unlimited
16. Gilroy Farm Bureau Center
17. Grass Valley Rifle, Rod and Gun Club
18. Indian Valley Grange
19. Key Rod and Gun Club
20. Lake Tahoe Archers, Inc.
21. Lake County Sportsmen's Association
22. Los Angeles County Rod and Gun Club
23. Mather Rod and Gun Club
24. Montebello Sportsmen's Club
25. Modoc County Cattlemen's Association
26. Monterey Cattlemen's Association
27. Napa Rod and Gun Club
28. Northeastern California Conservation League
29. Nevada County Sportsmen's Club
30. Northern Sonoma County Sportsmen's Club
31. Pentz Farm Center
32. Plumas-Sierra County Farm Bureau
33. San Diego Wildlife Federation
34. Santa Rosa Rod and Gun Club
35. San Fernando Valley Sportsmen's Club
36. Santa Maria Valley Sportsmen's Association
37. State Section, Isaac Walton League
38. Sacramento-Sierra Sportsmen's Council
39. Stockton Rod and Gun Club
40. Sportsmen of California
41. Sonoma County Farm Bureau
42. Sage and Surf Club
43. State Highway Rifle and Pistol Club of San Bernardino
44. Telco Rod and Gun Club
45. The Marching and Bird Watching Society of San Rafael
46. Truckee Outdoor Sportsmen
47. West Kern Sportsmen's Club
48. West Point Rod and Gun Club
49. Whittier Chapter, Isaac Walton League

APPENDIX II

Counties open to either-sex deer hunting during the last three days of the 1956 regular buck seasons:

Early Season

Alameda
Contra Costa
Los Angeles
Monterey
Napa
Orange
San Benito (except New Idria area)
San Diego (northwest corner)
San Joaquin (west half)
San Luis Obispo (except Pozo area)
San Mateo
Santa Barbara
Santa Clara
Santa Cruz
Solano
Ventura (except Frazier Mtn.)
Yolo

Late Season

Amador
Butte
Calaveras (eastern two-thirds)
El Dorado (west of the Sierra Crest)
Glenn
Lassen
Modoc
Nevada (west of Sierra Crest)
Placer (west of Sierra Crest)
Plumas
Sacramento
San Joaquin (east half)
Shasta
Sierra (except southeast corner)
Siskiyou
Sutter
Tehama
Yuba

PRODUCTIVITY IN SOME CALIFORNIA DEER HERDS[1]

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INTRODUCTION

Published reports on reproduction in California deer have been few. Chattin (1948) and Lassen et al. (1952) gave some data on the breeding success in the Interstate and Doyle Rocky Mountain mule deer herds. Reproduction in the Columbian black-tailed deer from the Cow Mountain area in Lake County has been described by Taber (1953), who found differences in reproductive success in the three chaparral types studied. Workers in other states have described reproductive differences including Robinette et al. (1955) who noted differences in productivity by regions as well as by year in the Rocky Mountain mule deer of Utah.

The first study made in California to obtain such data was made during the winter of 1946-47 when the California Fish and Game Commission authorized a collection of deer from the Interstate deer herd in order to make a critical study of food habits, disease and parasites, as well as obtaining data on breeding and reproduction. In subsequent years the commission authorized scientific collections from other herds in the State to obtain similar data which could be applied to better management of these herds. Descriptions of some of these areas and food habits analysis have been reported by Leach (1956), and Leach and Hiehle (1957). The breeding seasons of these herds has been reported by Bischoff (1957).

Acknowledgment is made of the co-operation of the Nevada Fish and Game Commission in allowing collections from the Lassen-Washoe herd in Nevada. The personnel of the United States Marine Corps, Camp Pendleton, allowed the collection of reproductive material during the special hunts. Mr. E. L. Sumner, Park Biologist of Sequoia National Park, assisted in obtaining specimens from the Sequoia Park herd. Special thanks are due to the above persons and to the various members of the California Department of Fish and Game who assisted in the various collections.

METHODS AND MATERIALS

Embryo counts were taken from does after conception became evident. In most cases, this was about four to six weeks after the breeding season of each deer herd. Embryos under 30 days development are small and can easily be missed in field examinations. It was assumed that the doe was not pregnant when evidence of an embryo was lacking

[1] Submitted for publication February, 1958. Funds for this study were provided through Federal Aid in Wildlife Restoration Project W-51-R, "Wildlife Investigations Laboratory."

after the six-week period even though corpora lutea were present. Fetuses were aged and sexed, and the sex ratios established. Robinette et al. (1957), has selected the crown-rump measurement of 50 mm as their limiting factor to determine sex with accuracy. This measurement is equivalent to 50 to 55 days development on white-tailed deer as described by Armstrong (1950). Therefore, sex was not determined on embryos under 50 days of age. Ovaries were examined by the method set forth by Cheatum (1949), and the ovulation and fertilization rates established.

Reproductive material was gathered from 322 adult does, 31 yearlings, and 20 female fawns from 11 herds representing five subspecies of deer. The collections made from the Tehama, Oak Knoll, and Hartstrand herds in 1951, and the Lake Hollow and Elephant Hill herds in 1955, made up the study of 102 Columbian black-tailed deer (*Odocoileus hemionus columbianus*). Forty-three Rocky Mountain mule deer (*O. h. hemionus*) from the Lassen-Washoe and the Truckee-Verdi herds were examined for productivity in 1951. Chattin's work on 49 Rocky Mountain mule deer from the Interstate herd is included in this report. The Doyle herd, as described by Lassen et al. (1952), is synonymous with the Lassen-Washoe herd. The Inyo mule deer (*O. h. inyoensis*) is represented by 35 females taken in 1952 from their winter ranges in Owens Valley. Sixty-eight deer from Camp Pendleton taken in 1955-56 represent the southern mule deer (*O. h. fulginatus*). Twenty-five California mule deer (*O. h. californicus*) were sampled from Sequoia National Park in 1955.

With the exception of the Lassen-Washoe herd, sampling was done only during a single year. For this reason, no attempt is made to correlate productivity with range conditions. Although 322 adult does were examined from 11 herds, no comprehensive statistical analysis was made, because, when individual herds are considered, samples become limited. Sampling of the fawn and yearling classes was very limited and this data is presented for the value it may have.

FINDINGS AND DISCUSSION

Reproduction in Columbian black-tailed adult does is summarized in Table 1. A pregnancy of 96 percent was found in 102 adults with a ratio of 166 embryos per 100 does. The lowest reproduction was found in the Oak Knoll herd with 154 embryos per 100 does. The highest reproduction of 173 embryos per 100 does was seen in the Tehama herd. The ovulation rate was likewise lower in the Oak Knoll herd—1.54 as compared to 1.91 from the Tehama herd. The rate of fertilization was about equal in the three herds examined. Data were not available to determine the rate of fertilization in either the Oak Knoll or the Hartstrand herds.

The embryo sex ratios showed great variation (80 to 177 males per 100 females) in the black-tailed herds. A factor in this spread may be inadequate sampling; the total of all black-tailed embryos (170) gave the ratio of 135 males: 100 females. Studies by Taber gives the sex ratio of black-tailed deer in Lake County as 127 males: 100 females. Taber and Dasmann (1954) give the probable sex ratio in black-tailed deer as 120 males: 100 females.

TABLE 1

Productivity in Columbian Black-tailed Deer Herds
(Adult females only)

Herd	Data after	Sample	Doe embryo	Percent pregnancy	Embryos per 100 females	Ovulation rate	Fertilization percent	Embryo sex ratio 100 females	Percent singles	Percent twins	Percent triplets
Tehama	1–51	22	22/38	95	173	1.91	90	80	29	61	10
Lake Hollow	12–55	17	17/28	100	165	1.76	93	137	41	53	6
Elephant Hill	11–55	20	20/34	100	170	1.85	92	164	30	70	0
Oak Knoll*	1–51	22	22/34	91	154	1.54	--	117	50	45	5
Hartstrand*	2–51	21	21/36	96	171	1.75	--	177	33	67	0
San Benito County	2–58	15	15/19	100	127	1.27	100	90	75	25	0

* Data taken from work sheets of Project California W-51R, Big Game Investigations.

TABLE 2

Productivity in Mule Deer Herds
(Adult females only)

Herd	Data after	Sample	Doe embryo	Percent pregnancy	Embryos per 100 females	Ovulation rate	Fertilization percent	Embryo sex ratio 100 females	Percent singles	Percent twins	Percent triplets
Lassen Washoe (Rocky Mtn. sp.)	12–51	23	23/34	91	148	1.69	87	64	38	62	0
Truckee-Verdi (Rocky Mtn. sp.)	1–51	20	20/30	95	150	1.70	88	200	42	58	0
Interstate* (Rocky Mtn. sp.)	1–47	49	49/32	98	175	--	--	113	29	67	4
Inyo (Inyo sp.)	2–52	35	35/58	100	166	1.83	89	205	34	66	0
Pendleton (Southern sp.)	11–55 & 11–56	68	68/104	94	153	1.73	88	76	38	62	0
Sequoia (California sp.)	5–55	25	25/44	100	176	1.88	94	92	24	76	0

* Chattin (1948).

The incidence of single and multiple embryos is presented on Table 1. Triplets were recorded only from three herds: two sets from Tehama and one set each from the Lake Hollow and Oak Knoll herds.[2]

The reproduction in four subspecies of mule deer in California is summarized in Table 2. The percent of pregnancy is high, ranging from 91 percent in the Lassen-Washoe herd to 100 percent in the Inyo and Sequoia herds. Cheatum and Severinghaus (1950) found a variation in white-tailed deer pregnancy from 79 percent to 94.8 percent from five regions in New York State. Robinette (*op. cit.*), in Utah found 94 percent pregnancy in adult does with two-year-old does exhibiting the highest rate of pregnancy.

The Sequoia herd of California mule deer was the only mule deer group examined to have over 90 percent of the ova produced fertilized. The remaining herds were in the high eighties. The ovulation rate averaged 1.75 per doe with the low of 1.69 in the Lassen-Washoe herd to 1.88 from the Sequoia herd. Robinette (*op. cit.*), reported that the ovulation rates increased with each age group in deer from Utah. This was true of the deer taken from the Buttermilk range of the Inyo mule deer. There also appeared a higher degree of fertilization in each progressing age class.

There was a variation in embryo sex ratio ranging from 64 at Lassen-Washoe herd to 205 males per 100 females in the Inyo study. Undoubtedly, insufficient numbers give this distorted ratio. Jones (1954) added to the above Inyo figure all embryos (total of 101) that could be sexed from Inyo mule deer and found the ratio to be 152 males: 100 females. Chattin found a ratio of 113 males, and Lassen found 107 males: 100 females in Rocky Mountain mule deer. Robinette (1957) lists the sex records of 2,299 fetuses of *Odocoileus hemionus* ssp. giving a sex ratio of 111 males: 100 females.

One set of triplets was found in the mule deer, and these were from the Interstate herd reported by Chattin (*op. cit.*).

Table 3 shows the reproduction in 31 yearlings from the various herds. Eleven are Columbian black-tailed deer and 20 are from three subspecies of mule deer. With such a limited sample, fertilization, ovulation rates, and the percent pregnancy have little significance. In all cases, pregnant yearlings carried single embryos with a sex ratio of one to one. In general, it is believed that yearling females tend to breed later than adult does. Our data indicates that yearlings breed three to four weeks after the first adults breed.

Examination of reproductive tracts from 20 fawns from the Southern and California mule deer showed no evidence of ovulation, although there was ovarian activity. Taber (*op. cit.*) found the same condition existed in black-tailed fawns from Cow Mountain.

The only herd from which data was taken for more than a single year was the Lassen-Washoe herd. Reproduction data was gathered from this herd during 1951 and again in 1956. As is indicated in Table 4 a slight increase in productivity was noted in 1956. Whether this is valid cannot be definitely determined because sampling was limited. However, during this interval of five years, some changes did occur

[2] Reproductive data was collected from black-tailed deer in San Benito County in February, 1958, and is summarized in Table 1.

on this range with regard to both the deer themselves and the environment. During this period an increasing number of deer were removed by antlerless hunts. Since the severe winters of 1951-52, subsequent winters have been mild and open. Deer were not forced onto the winter ranges and remained dispersed for longer periods of time. This, in turn, put less pressure on the winter range. The combination of reduced numbers of deer and the mild open winters no doubt increased the available forage and reduced certain stress factors such as crowding and competition for food.

Abnormal fetuses were found in four of the 11 deer herds examined. Robinette and Gashwilder (1950) reported three out of 318 mule deer embryos, or 0.9 percent of the fetuses to be absorbed or were malformations. During the study of the Inyo mule deer, three out of 96 or 3.2 percent of the fetuses were absorbed. In each case, the doe was carrying twins with a single fetus being absorbed. The sex could not be determined, as the fetuses were less than 50 days old. These adults were in the four- and five-year classes. Another doe, seven and one-half years old was carrying twin female fetuses approximately 121-126 days old. One was underdeveloped, measuring 21 mm (forehead-rump) less than its twin. The eyelids and mouth of the underdeveloped fetus were open.

A Rocky Mountain mule deer from the Lassen-Washoe herd was carrying two fetuses approximately 180 days old. The female fetus appeared normal, whereas the male was icteric. The fluid in both horns of the uterus was clear. Unfortunately, the specimen was not saved for further examination.

Bischoff (1954) reported a fetal cyclopean monster, which was taken from a normal four and one-half year old doe from the Truckee-Verdi herd. A normal twin was present.

Examination of pregnant does from the Camp Pendleton herd of southern mule deer during 1955 and 1956 revealed a high percentage of abnormal fetuses. Nineteen percent of the 64 pregnant does examined had abnormal fetuses. These abnormalities consisted of a shorten-

TABLE 3

Productivity in Yearling Deer

Herd	sample	Percent pregnant	Embryos per pregnant doe	Percent ovulation	Percent fertilization
Black-tailed					
Tehama	2	50	1.00	100	50
Lake Hollow	1	0	--	0	0
Elephant Hill	3	33	1.00	66	100
Oak Knoll	3	33	1.00	33	--
Hartstrand	2	50	1.00	50	--
Rocky Mountain mule					
Lassen-Washoe	2	100	1.00	150	67
Inyo mule					
Inyo	4	25	0.25	44	25
Southern mule					
Pendleton	14	73	0.85	59	91

TABLE 4

Reproductivity in Lassen-Washoe Herd
(Adult females only)

	1951	1956	Gain loss
Sample	23	28	
Doe embryo	23 24	28 46	
Percent pregnancy	91	100	+ 9
Embryo per 100 females	148	167	+ 19
Ovulation rate	1.69	1.83	+0.14
Fertilization rate	87	93	+ 6
Embryo sex ratio to 100 females	64	105	+ 41
Percent singles	38	23	— 15
Percent twins	62	77	+ 15
Percent triplets	0	0	0

ing or lack of the lower jaw, short limbs, umbilical hernia, and a generalized abnormal appearance of the entire skeletal structure. Robinette (*op. cit.*) reported a fetus with an umbilical hernia from Utah, but it did not have the shortened lower jaw or limbs. Only two of the 12 abnormal fetuses were males.

SUMMARY

Reproductive data was taken from 322 adult does, 31 yearling, and 20 female fawns from 11 California deer herds representing five subspecies of deer. With one exception all data on each herd were collected during a single year. Variations in productivity were found in the five subspecies studied, and in different herds of the same subspecies; and no comparison could be made of changes that might have been occurring over successive years.

The one herd which was studied for more than a single year did show some differences in productivity.

Although some ovarian activity was found in fawns, no evidence of ovulation was found. Yearlings were found to be breeding three to four weeks later than the adults.

With the exception of the Camp Pendleton southern mule deer herd the occurrence of fetal abnormalities in California deer is low.

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MENDOCINO NATIONAL FOREST STREAM IMPROVEMENT[1]

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INTRODUCTION

The population increase in California and the resulting heavy demands placed on the trout waters of the State have accelerated the development of new management techniques for increasing the productivity of streams. Stream improvement has been suggested as a partial solution to the problem.

Two methods of stream improvement that have proved successful in California are: (1) flow maintenance dams, which store water for release in streams during periods of low flow; and (2) stream clearance, which is especially applicable where anadromous fishes are concerned and a shortage of suitable spawning areas exists. Improvement consisting of the construction and placement of various devices in streams with the intent of creating shelter has generally not met with any great success (Ehlers, 1956).

The Mendocino stream improvement project was not concerned with any of the above methods. It was a basic research study designed to determine the possibility of manipulating riparian vegetation to increase shade and cover along exposed streams.

The origin of the project stems from a survey of Stony Creek and adjacent basins made in August, 1946. At that time generally poor conditions for trout prevailed, mainly because of high water temperatures and large populations of rough fish.

On the basis of this survey it was suggested that the severe floods of 1937-38 had removed the riparian vegetation, and that the resultant absence of cover and shade had reduced the productivity of the stream in terms of trout.

Late in 1950, the Inland Fisheries Branch (then Bureau of Fish Conservation) requested the Department of Zoology of the University of California to investigate the feasibility of re-establishing streamside vegetation. The experimental areas were to be selected from streams in the Little Stony Creek, Big Stony Creek, or Grindstone Creek basins, Glenn County. In 1951 a contract was arranged between the Wildlife Conservation Board and the University of California.

After preliminary surveys the Stony Creek basin was selected as the study area and field work extended from October 1, 1951, to October, 1952.

[1] Submitted for publication December, 1957. Project 7X-301 of the Wildlife Conservation Board.

The work was primarily an analysis of the survival of experimental plantings of vegetation, although other aspects which might bear on the feasibility of a planting program were also explored.

DESCRIPTION OF STONY CREEK BASIN

The area is in the Mendocino National Forest. Management policy under the United States Forest Service has been one of fire protection, facilitation of recreational use, and regulation of grazing by livestock.

Stony Creek basin contains the watershed contributing to the flow of Big Stony Creek at Stonyford and above. This well-defined watershed contains 97 square miles of mountainous country, and is bounded by steep peaks and ridges on all sides. Two peaks, Snow Mountain, elevation 7,054 feet, and Mount St. John, elevation 6,503 feet, and their slopes form nearly two-thirds of the surface area.

The higher regions (3,500 to 6,000 feet) are more or less densely covered with a coniferous forest. Below this (2,500 to 3,500 feet) the slopes are dominated by knobcone pine (*Pinus tuberculata*) and man-

FIGURE 1. Minimum flow of approximately four cubic feet per second in the South Fork during summer of 1952. *Photograph August 13, 1952.*

zanita (*Arctostaphylos* sp.). Below 2,500 feet the vegetation becomes typically Sonoran.

Sections of the South Fork and North Fork of Stony Creek, generally lying at elevations between 1,500 and 2,500 feet, were chosen as areas which could be benefited by improvement techniques. The lands immediately adjacent to these sections are mostly chamise-covered slopes, generally looked upon as being of limited value.

Precipitation is not evenly distributed throughout the year. Between late November and early May precipitation is heavy, while from June through September practically no rain falls. This is reflected in extreme fluctuations in stream flows. Air temperatures at Fouts Springs, elevation 1,700 feet, range between 18 and 112 degrees F. Records are not kept at higher elevations. The summers are hot and very dry.

STREAMS OF THE DRAINAGE

There are three principal streams, the North Fork, the Middle Fork, and the South Fork, originating at elevations from 4,000 to 6,000 feet and joining below Red Bridge at 1,450 feet to form Big Stony Creek (Table 1). Below 2,000 feet all but the Middle Fork have developed barren rubble flood plains (Figure 1) over which the small summer flows make their way, exposed to intensive insolation.

The Middle Fork flows in a deep gorge between Snow Mountain and Mount St. John. It is protected from the summer sun and maintains a high summer flow due to its extensive mountainous watershed. The temperature of this stream was never found to exceed 67 degrees F. It is the only one of the three main branches contributing a significant flow to Big Stoney Creek during the dry months of August and September. Big Stoney Creek between the mouth of the Middle Fork and the diversion dam is made suitable for trout by this influx of cold water.

TABLE 1

Stream Lengths and Watershed Areas in the Stony Creek Basin

	Length (miles)	Area (square miles)
Middle Fork	9	30
North Fork	10	23
South Fork	11	23
Mill Creek	7	12

Data compiled by various agencies on Stony Creek do not present a clear picture of its flood flows. Tremendous variations in flow of the streams of the basin have been observed. For example, peak discharge of the South Fork on February 1, 1952, was estimated at 1,500 cubic feet per second (c.f.s.). Five days later the flow was 700 to 800 c.f.s. On August 13, 1952, the minimum flow for the season was about 4 c.f.s.

SURVEY OF THE NATIVE VEGETATION

During the winter of 1951-52 it was found that even minor floods were severely damaging to volunteer riparian vegetation. Seedling plants of red willow (*Salix lavaigata*), cottonwood (*Populus fremontii*), and

FIGURE 2. Seedlings developed in a sand and silt bar formed by floods in 1950-51. *Photograph October 8, 1951.*

FIGURE 3. The sand and silt bar shown in Figure 2 following minor floods in the fall of 1951. All seedlings have been destroyed and the surface material of the bar has changed to coarse gravel. *Photograph December 10, 1951.*

white alder (*Alnus rombifolia*) were present on nearly all moist areas adjacent to the stream channel in the fall of the year. Figure 2 shows an abundance of natural seedlings of shade trees growing on the sand and silt bar left by the previous season's floods. Heavy storms late in November and in early December resulted in high stream discharges. Figure 3 shows the changes caused by the high water. The bar has changed from a silt and sand deposit to coarse gravel and all the vegetation has been removed. Despite the occurrence of isolated even-aged groves of young willows and alders along all the streams of the basin, natural recovery is, on the whole, insufficient to provide significant streamside shade.

An age and growth study of the vegetation cover along the lower two miles of the North and South Forks was made in order to determine the growth rates, the maximum size, and the shade-producing potential of the native arborescent species. An increment borer was used to determine age, height was estimated, and diameters were taken with a tape.

The area covered is a typically Upper Sonoran life zone, supporting such characteristic species as digger pine (*Pinus sabiniana*), blue oak (*Quercus douglasii*), valley oak (*Quercus lobata*), buck brush (*Ceanothus* sp.), and manzanita (*Arctostaphylos* sp.). A few dwarfed individuals of the Transition zone, such as ponderosa pine (*Pinus ponderosa*), incense cedar (*Libocedrus decurrens*), and Douglas fir (*Pseudotsuga taxifolia*), are found in favorable sites.

The data indicate that the growth of woody plants is generally slow, and that their maximum heights are not great. Even the rapid-growing alder grows slower than at higher elevations. Of all the species investigated, only cottonwood, willow, and alder satisfied the requirements of rapid growth close to the summer stream channel, and maximum shade production. Only alder showed a strong tendency to grow in thick, cool groves necessary to afford maximum stream cover.

RIPARIAN MANAGEMENT INVESTIGATIONS

The first year's work was concerned with selection of suitable species and development of practical and effective planting techniques. All plants native to the drainage from which seeds or cuttings were available were used, as they were considered best adapted to local conditions. A few plants not native but especially suited to conditions of the drainage were also used.

The planting program had a threefold objective: (1) to find species suitable for stream improvement in the Stony Creek drainage; (2) to find for each species the site or sites on Stony Creek for which it was best adapted; and (3) to determine the best planting methods for each site and species. Such broad objectives could not be fully realized in a single year, but much was learned.

Experimental plantings were made in small plots using small numbers of plants, so that close observation and attention to the fate of each individual could be made. Sites were chosen to permit the study of establishment and growth of plants under the whole range of variation of soil, moisture, and exposure. In general, however, favorable sites were scarce. Most of the area was hot and dry, with poor, gravelly soil. Planting stock was of three kinds: cuttings, seeds, and seedlings.

Survival of Cuttings

Dormant cuttings 18 inches to 2 feet long were collected during the fall and winter months. Some were planted immediately after gathering, while others were held in a nursery established by project personnel at Stonyford until spring. Owing to the rock and gravel of the streamside, cuttings could not be planted even by driving into the ground with a maul or sledge. Instead, holes of slightly greater diameter than the cuttings and 18 inches deep were forced into the ground with a crowbar, and the cuttings were then gently fitted in the holes and the soil tamped around them.

Early spring growth was browsed heavily by deer. Severe damage was also sustained later in the spring when stock was turned in. Barbed wire fences were erected about some of the cuttings to minimize losses. In general, however, such exclosures were not effective, since they were easily entered by deer.

Most species suffered heavy losses during the summer, due primarily to a combination of drought and animal damage. Early browsing retards growth and development. The result is that plant has neither the root system nor the vitality to withstand the summer heat and dryness. By the 12th of August, spice bush (*Calycanthus occidentalis*), creek dogwood (*Cornus californica*), plane tree (*Platanus racemosa*), squaw bush (*Rhus trilobata*), and elderberry (*Sambucus coerulea*) had failed completely. The few remaining cottonwood and snowberry (*Symphoricarpos albus*) cuttings were in very poor condition. Only mule fat (*Baccharis viminea*), willow, and California wild grape (*Vitis californica*) showed any vigorous growth. By the 20th of September only mule fat and willow remained in significant numbers (Table 2).

Those species which failed completely are probably unsuited to root under the conditions imposed by the environment of the experimental area. They might be rooted in a nursery and transferred to the field as potted stock. Cottonwood, mule fat, and willow survived well enough to show trends in the struggle for establishment. Figure 4 shows survival and losses for cottonwood cuttings which are fairly representative of the other species.

Results From Planting Seeds

Seeds of native plants were gathered in the fall and winter as they became available and planted in the field in prepared seed spots. Protection from seed-eating animals was provided by covering each seed spot with a cone of ½-inch mesh hardware cloth 8 inches high. Some seed spots were left without this protection as controls.

A high percentage of germination for the seeds of most species was obtained. Animal damage was light during the winter and early spring. The only serious losses sustained until May were due to floods. Seed plantings of this type are quickly washed away even by light floods. Certain large-seeded species, such as buckeye and black walnut, are exceptions, and if planted deeply to protect them from the force of the flood will usually survive.

When food became scarce late in the spring, rodents increased their activity and frequently burrowed beneath the wire cones to devour the sprouting seeds. Cattle and deer left the drying hillsides and wandered along the creek in search of green feed, trampling and destroying many

TABLE 2

Summary of Cutting Plantings to September 20, 1952

Species	Total number of cuttings	Number leafed out	Leafed-out cuttings destroyed by			Dormant cuttings lost to flood	Number alive		Total
			Animals	Flood	Drought		Browsed	Unbrowsed	
Mule fat (*Baccharis viminea*)	125	67	0	0	*17	19	50	0	50
Spice bush (*Calycanthus occidentalis*)	11	11	0	0	11	0	0	0	0
Cottonwood (*Populus fremontii*)	30	27	0	0	25	0	1	1	2
Creek dogwood (*Cornus californica*)	23	14	0	0	14	0	0	0	0
Plane tree (*Platanus racemosa*)	7	4	1	0	3	0	0	0	0
Squaw bush (*Rhus trilobata*)	12	12	0	0	12	0	0	0	0
Willow (*Salix spp.*)	251	237	0	0	159	20	73	5	78
Elderberry (*Sambucus coerulea*)	60	58	0	0	58	0	0	0	0
Snow berry (*Symphoricarpos albus*)	81	70	0	0	62	0	0	8	8
California wild grape (*Vitis californica*)	84	39	0	0	33	0	0	6	6

* Deaths recorded in this column are not due solely to drought. Some cuttings died only after they had been weakened by browsing. In practice these two causes augment one another and it is not possible to designate one or the other as the principal cause of death.

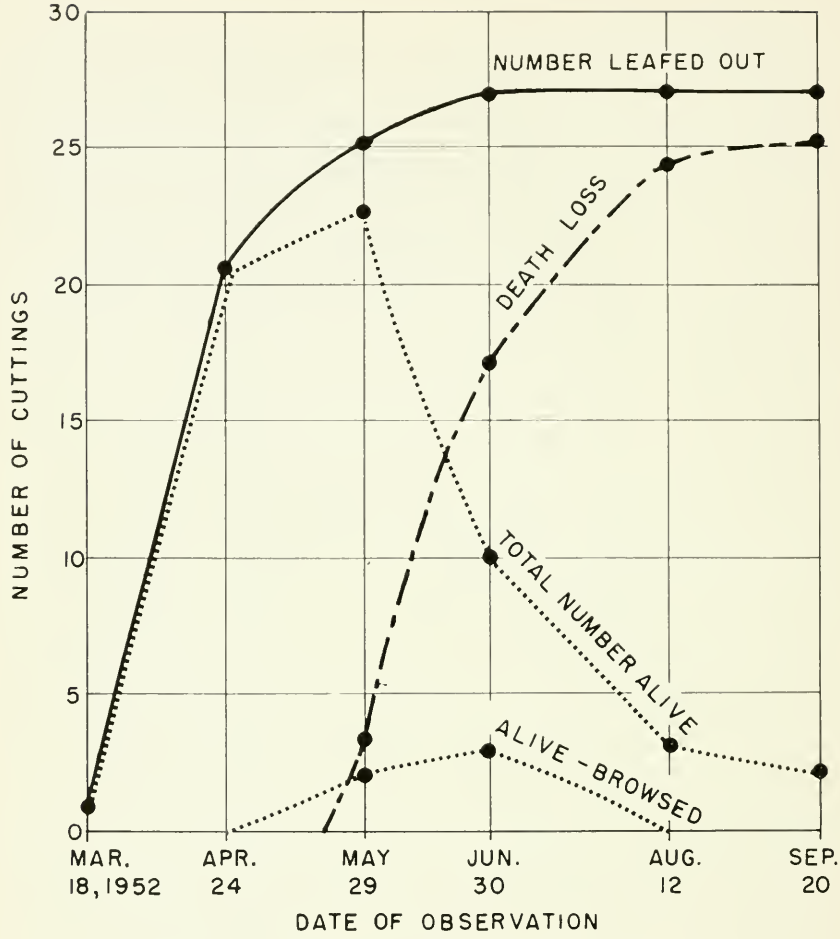

FIGURE 4. The survival of 30 Fremont cottonwood, *Populus fremontii*, cuttings planted in various sites.

more seed spots. A large number of seeds were detroyed despite the protection afforded by the cones. Loss of seeds planted without benefit of the cones was nearly complete.

As summer started, sprouting seeds began to suffer from heat and dryness and a constantly increasing number withered and died.

Of all the species tried, only buckeye (*Aesculus californica*), California black walnut (*Juglans hindsii*), and white oak showed promise. Only black walnut grew large enough and fast enough to be useful. Table 3 summarizes the results of the seed plantings. Figure 5, illustrating survival and loss of seedlings of black locust (*Robinia pseudocacia*) is characteristic of survival and loss for seed plantings.

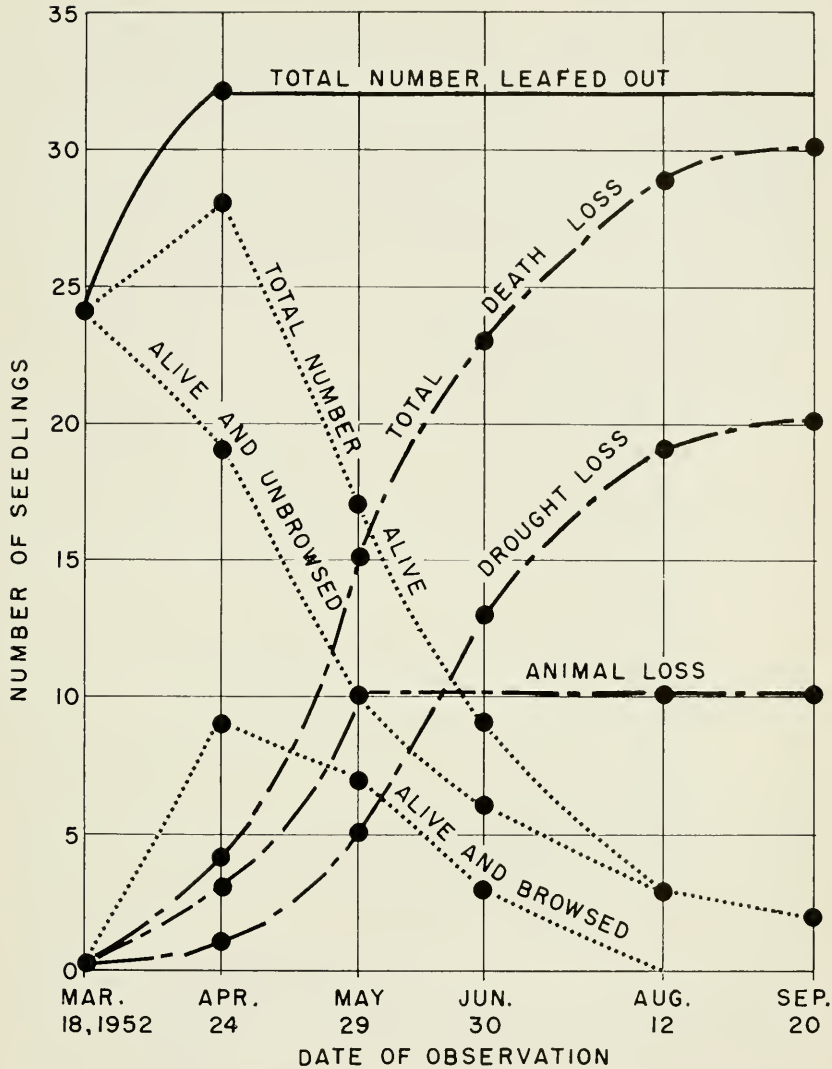

FIGURE 5. The survival of 35 first-year black locust (*Rabinia pseudacecacia*) seedlings planted on exposed rubble bars and east-facing chaparral slopes. These observations were carried out between January 10, 1952, and September 20, 1952, and include one regularly watered seedling.

Seedling Survival

The planting stock of ponderosa pine, hybrid pine, and black locust were all one-year-old bareroot seedlings. The alder and black walnut were also bareroot, but were two to three years old. The great majority of seedlings survived transplanting to the field and produced new growth in the spring. The losses remained low until April, then in-

TABLE 3

Summary of Seed Plantings to September 20, 1952

Species	Total number of seeds	Number germinating	Germinated seed destroyed by			Ungerminated seed destroyed by		Number alive		Total
			Animals	Flood	Drought	Animals	Flood	Browsed	Unbrowsed	
Big-leaf maple (*Acer macrophyllum*)	58	19	5	0	11	0	20	0	0	0
Box elder (*Acer negundo*)	56	3	0	0	1	0	48	0	2	2
Buckeye (*Aesculus californica*)	57	36	10	1	10	7	3	2	13	15
Judas tree (*Cercis occidentalis*)	15	24	0	0	17	0	0	0	7[1]	7
Foothill ash (*Fraxinus dipetula*)	20	0								
California black walnut (*Juglans hindsii*)	33	25	4	0	11	0	2	7[1]	3[2]	10
Tan oak (*Lithocarpus densiflora*)	8	3	0	0	3	0	0	0	0	0
Islay (*Prunus ilicifolia*)	35	22	1	0	17	0	8	0	4[3]	4
Maul oak (*Quercus chrysolepis*)	11	7	0	0	3	0	3	0	1	1
Leather oak (*Quercus durata*)	12	6	1	0	3	0	1	0	2	2
Valley oak (*Quercus lobata*)	38	21	6	0	7	0	2	0	8[1]	8
California laurel (*Umbellularia californica*)	25	1	0	0	0	0	9	0	1	1

[1] Six plants watered with five gallons once a week.
[2] Two plants watered with five gallons once a week.
[3] Three plants watered with five gallons once a week.
[4] Seven browsed and one unbrowsed growing in moist stream bank with afternoon shade.

creased rapidly. As in the instance of the cuttings, a combination of animal damage and drought was responsible for this loss.

All of the seedlings eventually died. The hybrid pine showed the greatest resistance, although it also succumbed.

Effect of Cultural Operations

In order to determine whether supplemental watering, fertilization, or shade might increase the survival of planted stock, a series of "multiple plantings" was initiated. Each multiple planting consisted of a group of seeds or seedlings of the same species planted on the same site, but differing in the amount of water, fertilizer, or shade supplied.

Twenty-nine seedlings of ponderosa pine were planted on an exposed east-facing road cut early in February. Beginning on April 24th, nine of the trees were watered once each week with five gallons of water; the balance received no treatment. About 60 percent of the watered group survived and showed fair growth. None of the untreated group was alive after the middle of August.

Of the 176 ponderosa pine seedlings planted during the year, a total of 19 was watered in accordance with the above schedule. About 65 percent of these watered individuals survived. Only about 5 percent of the untreated plants were alive on September 20th.

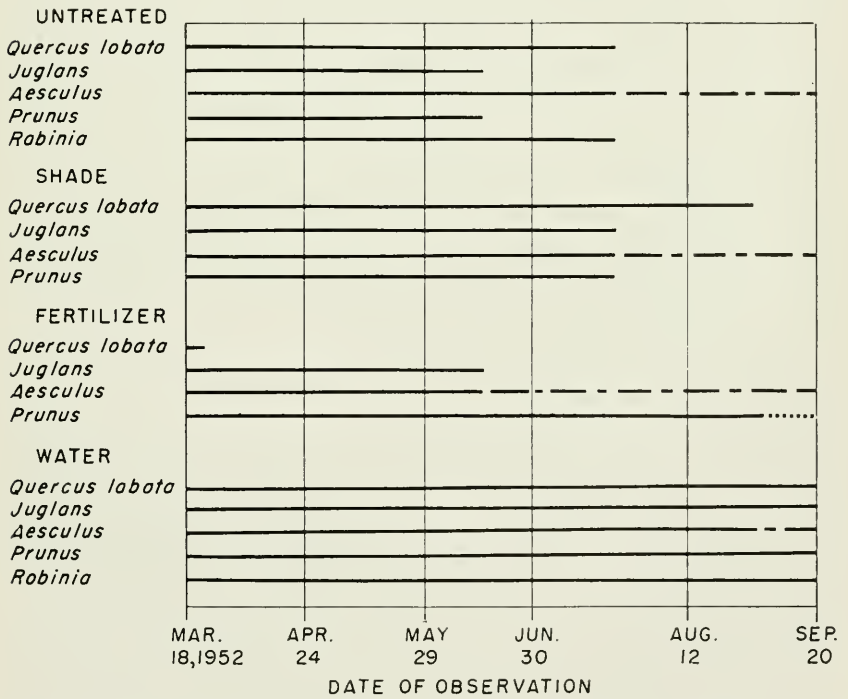

FIGURE 6. The effects of cultural operations on multiple plantings of seedlings on a rubble bar near Red Bridge. Solid line, alive and green; dot dashed line, alive but dormant; dotted line, badly wilted. Plants died at point where lines cease.

Multiple plantings of five species were made on a dry, exposed rubble bar on the South Fork. Each species was planted in an untreated site as a control. A second site was provided with shade from the summer sun, but given no other treatment. A third site was fertilized with commercial superphosphate and nitrate of ammonia. A fourth site was watered once a week with five gallons of water. The species used were valley oak, black walnut, buckeye, islay, and black locust. The only significant plant response was to water, as may be seen from Figure 6.

DISCUSSION

There were two factors, grazing and fire, in the history of the basin that suggested a general deterioration of the watershed might have taken place, with a corresponding decrease in the productivity of the streams.

Field observations and United States Forest Service records revealed that, except for the top of Snow Mountain, there has been no serious grazing damage in the basin. In 1952, 50 cattle whose grazing had serious effects on the stream were under permit. These cattle were not fenced and were free to graze anywhere in the basin. During the dry summer months the only green feed and water available were in the creek bottoms and grazing damage to low-growing riparian vegetation during this period was heavy. A great percentage of the vegetation planted for experimental purposes suffered loss or damage by cattle and deer.

It cannot be concluded from this, however, that grazing has caused the destruction of the naturally existing streamside vegetation, or that removal of the cattle or deer would result in a shaded stream. A meaningful analysis of the effect of grazing would involve extensive fencing and observations over several years.

Grazing damage to streamside plants does, however, make the protection of plantings by adequate exclosures advisable. Deer caused heavy plant damage whether the planting site was fenced or not, since they can easily jump the standard cattle fence. Deer-proof fencing such as the outrigger fence described by Blaisdell and Hubbard (1957) was not available at the time of this study.

Rodents find and destroy all unprotected seed plantings. Wire mesh cones placed over the seeds at the time of planting provide protection that is only partly effective.

Even though no major fires had occurred on the North Fork for 30 years prior to 1946, a survey made that year indicated that conditions in this stream were unsuitable for trout during the summer. Comparison of the 1946 data with data taken by the authors in 1952, four years after a major fire had swept through the entire North Fork watershed below the 3,500-foot elevation, showed no substantial change in stream temperature, stream flow, or fish populations.

There is no evidence to indicate that recent fires have been much different in frequency or extent from those set by Indians and early white settlers. Any changes in the streams due to the effects of fire have almost certainly been gradual. There is little to support the idea that the streams of the drainage have undergone any physical deterioration in recent times.

The results of this study indicate that the streamside vegetation is limited to its present state by climate. The total water supply available from rainfall and seepage through the soil is not sufficient for rapid or extensive growth. This shortage is aggravated by the fact that precipitation does not occur during the hot growing season, when the vegetation could make the best use of it. Increment borings illustrate the extremely slow growth of both riparian and other species in the area.

Vegetation planted close enough to the summer stream course to have access to water during the dry season is menaced by the frequent spring floods characteristic of the drainage. There is no assurance that any individual plant within the flood channel will survive to shade the stream unless it is given protection from the force of the floods. Rock dams and large single boulders are of little use as protective devices, since they seldom remain in place during a heavy flood. Deep planting of large seeds such as buckeye and black walnut partially survived. If deeply set, large cuttings of willow occasionally survived.

Only occasional plants in favorable locations become established and survive under natural conditions. The use of agricultural practices and methods is necessary for effective establishment of plants in the experimental area. Frequent waterings are of prime importance. The application of fertilizers may be helpful.

There is no basis for concluding that either recent fires and their associated floods or grazing by cattle have caused a disappearance of natural streamside vegetation from Stony Creek and its tributaries. The present state of the vegetation is probably very close to the natural one.

SUMMARY

1. In 1951 a contract was arranged between the Wildlife Conservation Board and the University of California to investigate the feasibility of establishing streamside vegetation for cover.
2. Stony Creek Basin, a 97-square mile watershed in western Glenn County, was selected as the experimental area. Field work began in October, 1951, and continued until October, 1952.
3. The basin had a history of heavy floods. Severe fires had occurred and grazing by cattle and deer was significant.
4. A survey of the natural vegetation indicated that floods were severely damaging to volunteer riparian vegetation. An age and growth study showed that growth of woody plants was generally slow. Cottonwood, willow, and alder all grew rapidly close to the stream channel. Only alder showed a tendency to grow in thick, cool groves and to provide adequate stream cover.
5. A planting program was undertaken in which cuttings, seeds, and seedlings were used in an effort to find suitable species, sites, and methods for establishing streamside cover.
6. Of the cuttings, only cottonwood, mule fat, and willow survived drought, floods, and grazing enough to show trends.
7. Although a high percentage of germination of seeds was obtained, only buckeye, white oak, and California black walnut survived rodent predation, floods, drought, and grazing enough to show

promise. Wire cones were necessary to prevent seed loss from rodents.

8. Five different species were planted as bare root seedlings. All of these died, primarily due to drought and grazing.
9. In order for natural streamside vegetation to be significantly augmented, agricultural operations such as fencing, irrigation, and perhaps fertilization are indicated.
10. Streamside vegetation is limited to its present state by climate. There appears to be no real basis for concluding that fires, grazing, or floods have caused a significant change from the natural state.

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THE SHORTNOSE SPEARFISH
TETRAPTURUS ANGUSTIROSTRIS TANAKA

A SPECIES NEW TO THE NEAR SHORE FAUNA OF THE EASTERN PACIFIC OCEAN [1]

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On August 31, 1957, while trolling for albacore near the Sixtymile Bank, Baja California (lat. 32° 05′ N., long. 118° 14′ W.), Mr. Louis Sadler, owner of the vessel California Republic, caught a single specimen of what he believed to be a Pacific sailfish. Since Mr. Sadler was headed toward San Pedro to discharge his load of fish, the specimen was placed in the vessel's refrigerated hold. Upon arrival in port the "sailfish" was placed in cold storage under the custody of Mr. Billy Rice, operator of the bait hauler Sunshine II, who arranged for its delivery to the California State Fisheries Laboratory on September 3, 1957.

The Pacific sailfish (*Istiophorus greyi*), a common member of the sailfish family on the west coast of North America, is very rare north of Cape San Lucas, Baja California. Although Walford (1937) states that sailfish are found on the Pacific Coast as far north as Monterey, a search of the literature and contacts with several authoritative sources uncovered no specific record of this species from California. However, several reports of sailfish in California waters came to the attention of the California State Fisheries Laboratory during 1957. A personal contact by one of the biologists indicated the capture of a sailfish by a commercial fisherman off San Clemente Island, California, about the first of September. Another sailfish was reported to have been captured about the same time even farther north, some 60 miles offshore between Point Arguello and Morro Bay. At present facts necessary to substantiate these reported captures are insufficient to warrant considering them as positive records of Pacific sailfish from California waters, but in both cases mention by the fishermen of an extremely high dorsal fin leaves little doubt concerning the identity of the specimens.

The only member of the sailfish family definitely recorded from California waters is the striped marlin, *Makaira audax*, a number of which are caught each year by sport fishermen.

The fish captured by Mr. Sadler was neither a sailfish nor a marlin but a shortnose spearfish, *Tetrapturus angustirostris*, (Figure 1) a third member of the family Istiophoridae. Although superficially re-

[1] Submitted for publication December, 1957.

sembling the Pacific sailfish, a distinctly short snout, short pectoral fin, and lack of the characteristic sail-like dorsal fin positively identified the specimen.

FIGURE 1. Shortnose spearfish, *Tetrapturus angustirostris*, taken near Sixtymile Bank, Baja California, August 31, 1957. *Photograph by Jack W. Schatt.*

According to LaMonte (1955) the two currently valid species of *Tetrapturus* are considered rare throughout their range, with authentic occurrences only from the following areas: Florida, northern France, Sicily, Hawaiian Islands, Formosa, and Japan. Nakamura (1943) considers the Pacific species, *T. angustirostris*, to be common in the western Pacific Ocean, particularly around Japan.

Cruise reports of the Pacific Oceanic Fishery Investigations (Graham, 1957) provide the most recent published record of the occurrence of *Tetrapturus* in the Pacific Ocean. Of four specimens caught during the course of these surveys, two were taken near the Hawaiian Islands. A third was taken while trolling roughly 800 miles west of Point Conception (between lat. 35° 44′ N., long. 135° 58′ W., and lat. 34° 13′ N., long. 137° 44′ W.). This proved to be the easternmost record of this species, since the fourth specimen was taken about 200 miles farther west (approximately 1,000 miles from Point Conception) on longline gear.

Thus, the specimen from the Sixtymile Bank, approximately 60 miles southwest of San Diego, represents an eastward range extension for *Tetrapturus angustirostris* of nearly 1,000 miles and also adds another genus and species to the pelagic fauna of the temperate west coast of North America.

Measurements and counts of this specimen are presented in Table 1, together with the proportions expressed as thousandths of both standard length and "orbital standard length" (anterior of the fleshy orbit to the end of the hypural plate).

The characteristic elevated dorsal fin rays of *Tetrapturus* appear to be intermediate between those of *Makaira* and those of *Istiophorus*. In *Makaira* the extreme anterior portion of the dorsal fin is moderately elevated but tapers sharply toward the posterior end, with the last few rays difficult to distinguish. In *Istiophorus* the anterior portion of the dorsal fin is moderately elevated, becoming conspicuously elevated toward the posterior end. Only moderate elevation throughout its length is noted in the dorsal fin of *Tetrapturus*.

The other two diagnostic characters of *Tetrapturus*, short pectoral fins and short snout, were typified in this specimen, measuring 7.8 and 6.7 times in standard length, respectively. In the other two istiophorids with which *Tetrapturus* might be confused, these proportions are roughly 6.0 and 4.0 times in standard length, respectively, as estimated from photographs.

TABLE 1

Measurements of Tetrapturus angustirostris Together With Proportions of Standard Length and Orbital Standard Length (Anterior of the Fleshy Orbit to End of the Hypural Plate)

	Length in millimeters	Thousandths of standard length	Thousandths of orbital standard length
MEASUREMENTS:			
Standard length	1,529	--	1,142
Anterior of orbit to end of hypural plate (orbital standard length)	1,339	876	--
Anterior of orbit to opercle	175	114	131
Fork length	1,579	1,033	1,179
Head length	402	263	300
Snout length	229	150	171
Fleshy orbit	35.5	23	27
Least suborbital width	13	9	10
Bony interorbital width	61	40	46
Maxillary length	273	179	204
Mandible length	211	138	158
Pectoral length	197	129	147
Pelvic length	333	218	249
Fourth dorsal ray (longest)	186	122	139
Anal height (greatest)	112	73	84
Snout to first dorsal insertion	343	224	256
Snout to pectoral insertion	409	267	305
Snout to anal insertion	1,008	659	753
Snout to pelvic insertion	424	277	317
Pectoral insertion to first dorsal insertion	185	121	138
Pelvic insertion to first dorsal insertion	1,015	664	758
Anal insertion to dorsal contour (perpendicular)	141	92	105
Greatest body depth (pelvic insertion)	170	111	127
Greatest body width (pelvic insertion)	75.5	49	56
Least caudal peduncle depth	48	31	36
Least caudal peduncle width	45	29	34
First dorsal base	971	635	725
Dorsal finlet base	62	41	46
Anal base	197	129	147
Anal finlet base	65	43	49
Dorsal keel length	41	27	31
Ventral keel length	44	29	33

COUNTS:	
Dorsal	III, 46-6
Anal	II, 12-7
Pectoral	I, 17
Pelvic	I, 1
Branchiostegal rays	7

A weight of but $21\frac{3}{4}$ pounds for its length of approximately five feet well illustrates the strikingly fusiform body shape.

The gonads of both sexes in all of the istiophorids are reportedly often asymmetrical. Both testes in this immature male specimen appeared to be of equal size.

No food organisms were present in the stomach but the existence of an extremely short intestine leaves little doubt of the carnivorous food habit of *Tetrapturus*.

Some confusion seems to exist regarding the status of the dorsal fin elements in this species, as well as those of the other members of the family. Some authors refer to all the elements as being spines, others as varying combinations of spines and rays. The first three elements in the dorsal fin of the present specimen were considered to be spinous in

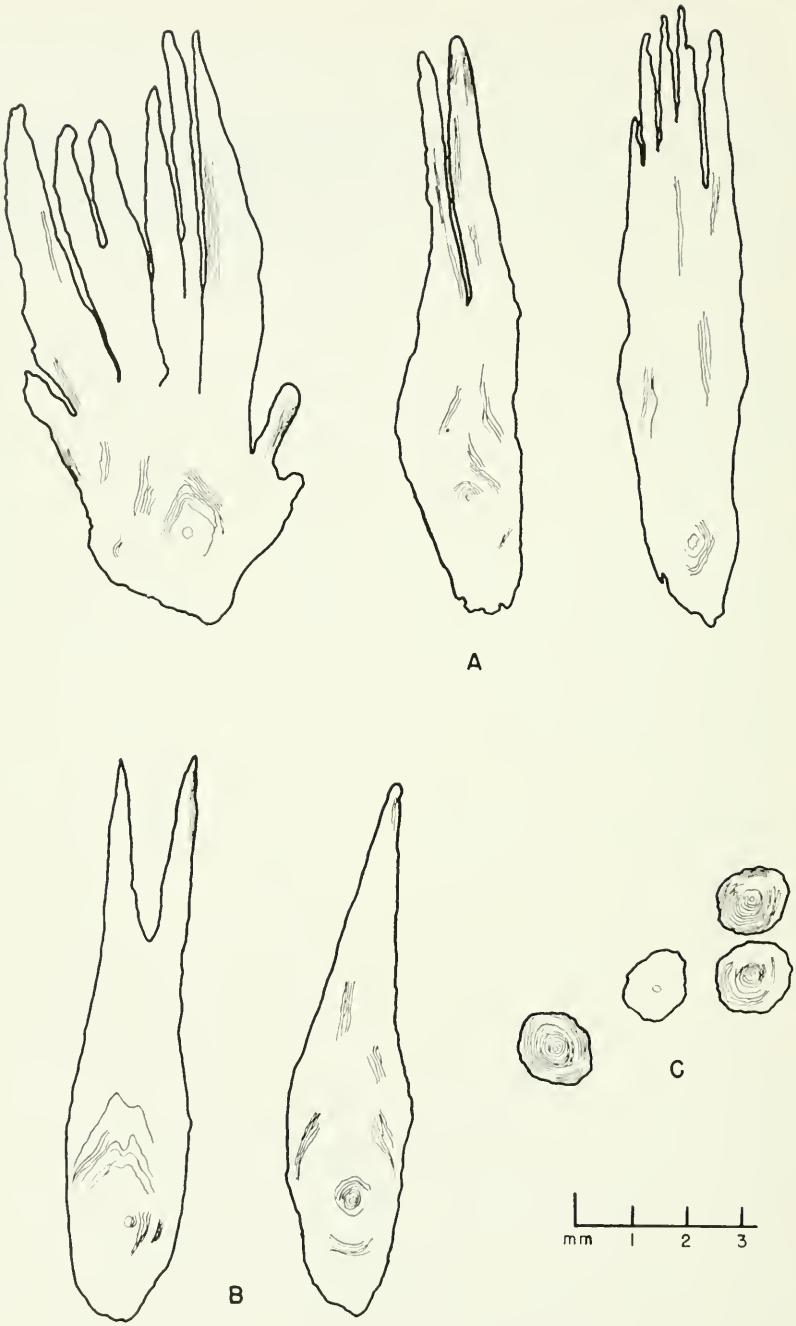

FIGURE 2. Camera lucida drawings of scale outlines. (a) *Tetrapturus angustirostris;* (b) Adult *Istiophorus greyi;* and (c) Juvenile *Istiophorus greyi.*

structure. Though completely unbranched, the remaining dorsal fin elements were considered to be more characteristic of rays. The finlets were composed of typically multibranched rays.

Because of their unusual furcate shape, the scales of *Tetrapturus* appear to be quite distinct (Figure 2A). Very few of the randomly taken scales were of the bifurcate type but were predominately multifurcate. For comparison the scales of a 327-mm. juvenile and those of an adult sailfish, *Istiophorus greyi* (exact size unknown), are shown in Figures 2C and 2B. The scales from the juvenile are quite nondescript, being typically cycloid, while those of the adult are elongate, much as in *Tetrapturus*. The obvious difference in scale structure between the two species lies in the number of projections. In the random scale sample from the adult sailfish those scales with a single projection dominated heavily over those with a bifurcate projection. None of the typically multifurcate scales of *Tetrapturus* were noted in the sample of *Istiophorus* scales.

No marlin scales were available for comparison, but LaMonte (1955) describes them in the adult stage as being "more or less flattened, elongate, and thorn-shaped, sometimes bifid." This indicates that the scales of *Makaira* more closely resemble those of *Istiophorus* than those of *Tetrapturus*.

Since this specimen was out of the water only about 72 hours before examination, the colors were considered quite indicative, though probably not as vibrant and iridescent as in life. A deep lead-blue best describes the color of the back above an imaginary line from the snout, along the upper edge of the orbit, and running posteriorly through the dorsal caudal keel. Both the ventral and anal fins were similarly colored. The flanks, including the pectoral fins, shaded from blue to the chalky white of the belly. The cheeks, below the eye were an iridescent silver color.

This specimen of *Tetrapturus angustirostris*, a new record for the extreme eastern Pacific Ocean, has been deposited in the fish collection, Department of Zoology, University of California, Los Angeles.

ACKNOWLEDGMENTS

Sincere thanks go to Mr. Louis Sadler and Mr. Billy Rice for their respective parts in making this specimen available for examination. A great deal of credit for the publication of this note is due Mr. John Fitch, Research Director of the California State Fisheries Laboratory, for without his stimulus, counsel, and guidance the manuscript would never have been concluded.

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FIRST RECORD OF THE AGONID FISH *PALLASINA BARBATA AIX STARKS* FROM CALIFORNIA[1]

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W. I. FOLLETT
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The capture of a tubenose poacher, *Pallasina barbata aix* Starks, at Cleone Beach, Mendocino County, California, extends the recorded range of this fish approximately 170 miles southward and adds another species to the fauna of California.

The poacher was taken on July 20, 1957, with a number of surf smelt, *Hypomesus pretiosus* (Girard), by James Hartman while fishing with a surf net, at approximately 2 p.m., which was at midtide in a neap-tide series. Cleone Beach consists of coarse sand. It is some three miles north of Fort Bragg, its approximate position being latitude 39° 29′ 30″ N., longitude 123° 48′ 00″ W.

In the dried condition in which the specimen reached us, it measured 127 mm. in standard length and $5\frac{21}{32}$ inches in total length. It is an adult female, containing ova to 1.8 mm. in diameter. The meristic counts are as follows: dorsal VIII, 7; anal 11; pectoral 11-11; pelvic 1,2-I,2; caudal (principal) 6 + 5; branchiostegals 5-5; prepelvic median plates 3; plates before spinous dorsal 11; spinous dorsal on plates 12-20; lateral line pores 45; vertebrae 15 + 32 = 47. The mental barbel is indistinguishable. The specimen is catalogued as No. 26307 in the Department of Ichthyology of the California Academy of Sciences. Although the photograph (Figure 1) does not show the two dorsal fins or the single barbel on the tip of the lower jaw, it does show the tubelike snout which distinguishes this species from the other 12

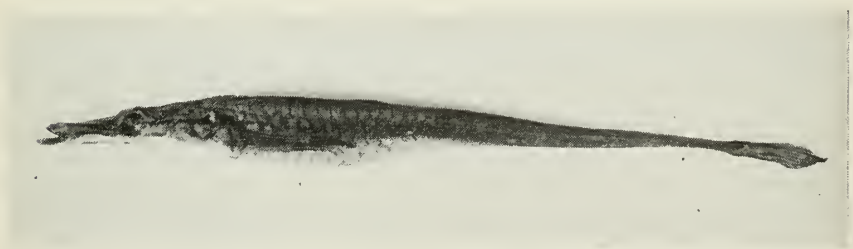

FIGURE 1. Tubenose poacher, *Pallasina barbata aix* Storks, S. L. 127 mm., T. L. 5-21/32 ins., Calif. Acod. Sci. Cat. No. 26307. *Photograph by W. I. Follett.*

[1] Submitted for publication March, 1958.

species of the family Agonidae that are known from California. An excellent figure of this poacher accompanied the original description (Starks, 1896, pl. 75) and another was published by Barraclough (1932, fig. 1).

The scientific name of the southeastern representative of the genus *Pallasina* has long been a matter of uncertainty.

Steindachner (1876, p. 188) originally described the species *Siphagonus barbatus* on the basis of specimens from the Arctic Ocean near Bering Strait and from Hakodate and Nagasaki, Japan. Gilbert (1895, p. 476) used the same name for specimens taken in a seine haul at Port Angeles, Washington. Later, Cramer (1895, p. 815), regarding the genus *Siphagonus* Steindachner (1876, p. 188) as synonymous with the genus *Brachyopsis* Gill (1861, p. 77), erected for *Siphagonus barbatus* the new genus *Pallasina*, "distinguished from *Brachyopsis* by the long, Syngnathus-like body, and by the presence of a long barbel at the chin."

Starks (1896, p. 558) described from Puget Sound, near Port Ludlow, Washington, a new species, *Pallasina aix*, which he distinguished from *Pallasina barbata* by the "much shorter barbel on chin, * * * two median plates in front of ventrals in place of three, and * * * the plates between the median and lateral plates much smaller and less regular in arrangement."

Thereafter, *Pallasina aix* was treated as a distinct species by Jordan and Evermann (1898, p. 2050), Scofield (1899, p. 504), Jordan and Gilbert (1899, p. 472), Evermann and Goldsborough (1907, p. 328), Starks (1911, p. 194), Halkett (1913, p. 105), Kincaid (1919, p. 35), Powers (1921, p. 3), Hubbs (1928, p. 14), and Jordan, Evermann, and Clark (1930, p. 394).

Gilbert and Burke (1912, p. 65) suggested that *Pallasina aix* is only subspecifically distinct from *Pallasina barbata*. They regarded the form occurring from Bering Strait to Herendeen Bay (midway of the northern shore of the Alaska Peninsula) as referable to *Pallasina barbata barbata*, and that from Unalaska to Puget Sound as representing *Pallasina barbata aix*. We follow this interpretation, which was accepted by Schultz and DeLacy (1936, p. 133), Schultz (1936, p. 183), and Wilimovsky (1954a, p. 24; 1954b, p. 286), and was discussed and used by Barraclough (1952, p. 146).

We have found no published record of this poacher from farther south than "Oregon" (Jordan and Evermann, 1898, p. 2050). The record of *Pallasina barbata aix* from Cleone Beach, which is approximately 170 miles south of Oregon, is therefore a substantial extension of the recorded range.

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REVIEWS

Fleas, Flukes and Cuckoos

By Miriam Rothschild and Theresa Clay; The Macmillan Company, New York, 1957; xiv plus 305 p., 99 black and white photographs, 4 maps, and 22 drawings. $5.00.

Here is a book that deals with one part of the facts of life: the birds and the bugs. It delves into the private lives of the birds as well as those invertebrates intimately associated with the birds. It is the association that receives the emphasis, for in reality this is a treatise on avian parasitology. But far removed from the ponderous tomes on parasitology, the volume is delightfully different in style, at least enough to provide light and interesting reading. In fact some of the passages are reminiscent of "Pogo," e.g., "the thought of a tapeworm as long as a cricket pitch living secretly in the stomach of a film star, or a beetle quietly chewing the feet of a close sitting hen * * *," or "Is it possible that a remora, twitching in their buccal cavities, assuages feelings akin to loneliness or boredom with which the sunfish and swordfish are otherwise afflicted?," and again, "It is impossible to know for certain if a duck is tickled or worried by the leeches attached to its vent, but it is unlikely that they are beneficial." These quotations illustrate the many whimsical descriptions liberally used throughout. However, let me hasten to add that there is sound scientific content and organization that one might find in a dull standard text. The authors have further enlivened the book with accounts of first-hand observations many of which are rather startling.

The first six chapters orient the reader with descriptive definitions of terms, generalizations on hosts and parasite relations, and theoretical considerations of origin and evolution. The seventh and eight chapters are devoted to the fleas and lice, and they constitute the most comprehensive section of the work. This is not surprising when one knows that Miss Rothschild is a leading authority on bird fleas, and Miss Clay is the world's leading authority on bird lice. The next eight chapters are somewhat too brief as discussions of the protozoa, helminths, microparasites, ectoparasites other than fleas and lice, the skuas and cuckoos.

Rounding out the book are many beautiful illustrations and photographs. A reference list for each chapter is included as an appendix containing some important citations, but unfortunately omitting several classical contributions, especially in relation to the viral and bacterial diseases of birds. There is a useful index of popular and scientific names, designed to broaden the prospective audience for the book.

This is a special volume of the New Naturalist series, and as such it is properly included, because it should have significant appeal to amateur naturalists and biologists as well as special interest to professional biologists and parasitologists.—*Merton N. Rosen, California Department of Fish and Game.*

San Francisco Bay

By Harold Gilliam; Doubleday & Company, Inc., 1957, 336 p., $4.50.

In "San Francisco Bay" the author has accomplished an ambition of many a newsman; that of writing a book. In so doing he has given, as the description on the jacket states, "A factual and fascinating account of the history, life and lore of California's vital inland sea." The reader is first educated in the geological evolution of the bay and its climatology. Next the events leading to the discovery and development of this great natural harbor into one of the largest and finest in the world are woven into an absorbing historical account.

With the authority of a long-time resident of the Bay area, Mr. Gilliam adroitly describes the profound effect the bay has had on the communities about its shores. It is interesting to note how the elements, mode of transportation, and other similar circumstances influence the daily lives of the residents of the area and, furthermore, how the bay has influenced the types of commerce and industry. The author

(all too briefly) also discusses the converse situation, how man has affected the bay and the life beneath it.

The islands of the bay are each treated in some detail, giving an account of their historic and present use. As opportunity develops, the various legends having to do with the islands, sea monsters, ships and shipwrecks, and hidden treasures are brought out.

Finally, the author presents the intriguing story and persistent efforts behind the construction of the great spans across the bay and the Golden Gate.

As a conservationist, it is perhaps with a prejudiced eye that this reviewer points to the scanty treatment of the role played by our fish and wildlife resources in the development of the Bay area. The importance of the bay in the military program could profitably have been treated in more detail.

It is unfortunate that any manuscript describing San Francisco Bay should be without photographs or drawings. One can scarcely imagine the bay without its symbols. The Golden Gate, the two monumental bridges, Fisherman's Wharf, the Embarcadero, the ferry building, and Alcatraz; these and many others tell a story impossible to describe adequately in words alone.

This is the first contemporary work about the bay and will be useful and informative to tourists and residents alike. The subject has been treated in an interesting manner and should appeal to all who have wondered about or are acquainted with San Francisco Bay. From the content, it is obvious that the author has made an extensive search of the literature and personally acquainted himself with many of the phases of activity on the bay, about which he writes.—*John E. Skinner, California Department of Fish and Game*

Vertebrates of the United States

By W. Frank Blair, Albert P. Blair, Pierce Brodkorb, Fred R. Cagle, and George A. Moore; McGraw-Hill Book Company, New York, 1957; $6\frac{3}{4}$ x $9\frac{1}{2}$ in.; ix plus 819 p., illus. $12.

This volume represents the culmination of an ambitious undertaking: a clearly written coverage of all the vertebrates within the continental United States. Intended as a much-needed text for students in taxonomic courses and related fields, it promises to be a useful reference for practicing biologists as well. Many of the latter have undoubtedly felt a need for a comprehensive yet concise reference source, and this work adequately fills that need.

The text is arranged naturally in six separate but co-ordinated sections covering each of the five classes of vertebrates, plus an absorbing introduction. Among other things, the introduction contains a simplified history of vertebrate evolution and a good discussion of the theories used to explain speciation.

Systems of classification followed are: Berg, *Classification of Fishes, Both Recent and Fossil* (1947); Schmidt, *A Checklist of North American Amphibians and Reptiles* (1953); Miller and Kellogg, *List of North American Recent Mammals* (1955); A. O. U., *Checklist of North American Birds* (1931), and Supplements (1944-1956).

The sections are arranged logically and follow the evolutionary path from fishes through mammals. Dichotomous keys and distribution lists are provided to the species level. Keys are based on external characteristics or other easily determined features when possible.

The first section after the introduction, fishes by Moore, is very good. Coverage is inclusive of all save marine species. The ommission is regrettable, but it is probably necessary for reasons of economy. This section is easily the most outstanding in the book. Although it leaves little to be desired, it might have been appropriate to mention in greater detail some of the more interesting variations within the genus *Salmo*. This could have been done without use of names, thus avoiding complications of trinomials. According *Salmo whitei* species status seems questionable. Perhaps it might better have been disregarded entirely, as were subspecies of *S. clarkii* and *S. gairdnerii* of equal or greater importance. In other respects, the brief mention of the confused relationships existing among the trouts seems adequate, within space limitations imposed, to summarize the actual situation. The bibliography is the most adequate of any chapter in the book.

Amphibians by A. P. Blair, and reptiles by Cagle are amply covered, but illustrations are limited, perhaps due to space limitations. One unaccountable ommission is marine turtles. The need for a marine turtle key and a distributional list seems fairly evident. It certainly would not require much space, and it would be useful. Bibliographies for both chapters are adequate, but brief.

The treatment of birds by Brodkrob may reflect his personal feelings to excess in regard to importance of various characters useful in systematics. The introductory material is fairly brief, and his stress of intestinal loop patterns at the expense of other features may prove undesirable. The chapter is sparsely illustrated, but is very good, nevertheless. The one serious fault is the omission of a bibliography. This should be remedied in future editions.

Mammals by W. F. Blair appears to be well organized. Recent changes in nomenclature and terminology are included where appropriate, yet controversial genera are left undisturbed. Aquatic mammals are included, which seems inconsistent with the exclusion of marine turtles from the chapter on reptiles. The bibliography, with its 70 listed references, should prove adequate.

Undoubtedly, some readers will find errors they consider worthy of considerable criticism in the book. Personally, I find it difficult to refrain from using superlatives in describing my impressions of its high overall quality. It is an excellent assemblage of many facts.—*James H. Ryan, California Department of Fish and Game.*

North American Head Hunting

By Grancel Fitz, Oxford University Press, Inc., New York, 1957, xxvi plus 188 p. illus. $4.75.

The author has had published in this volume 10 accounts of what he has expressed as the high spots in his lifetime of hunting big game in North America.

His objective, to collect a trophy head of each of the 20-odd big game species, has been attained, and if, in narrating the accounts of each of these hunts, the author has tended to "brag a little" the humility expressed by the author in dedicating the book to the guides "that made these adventures possible" would condone this frailty in any hunter.

After the foreword in which considerable effort was made to justify man's reasons and desires to hunt; the author takes you on 10 trips for 10 different species of North American big game from the Arctic Circle for polar bear, to Mexico for desert bighorn sheep.

Although this reviewer had read some of these stories which have been published in sportsmen's magazines, the unabridged and more detailed narration, used with fresh material, makes the book more enjoyable.

Professional hunters will appreciate the careful reasoning that went with choosing the areas in which to hunt for trophies, the meticulous care given to his guns and to the skill of the guides.

Amateur and armchair hunters will relish the skill of the writer in describing the habitat, the hunt and the actual kill.

The book is recommended to all trophy hunters as well as the casual reader of outdoor adventure stories.—*George D. Seymour, California Department of Fish and Game.*

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